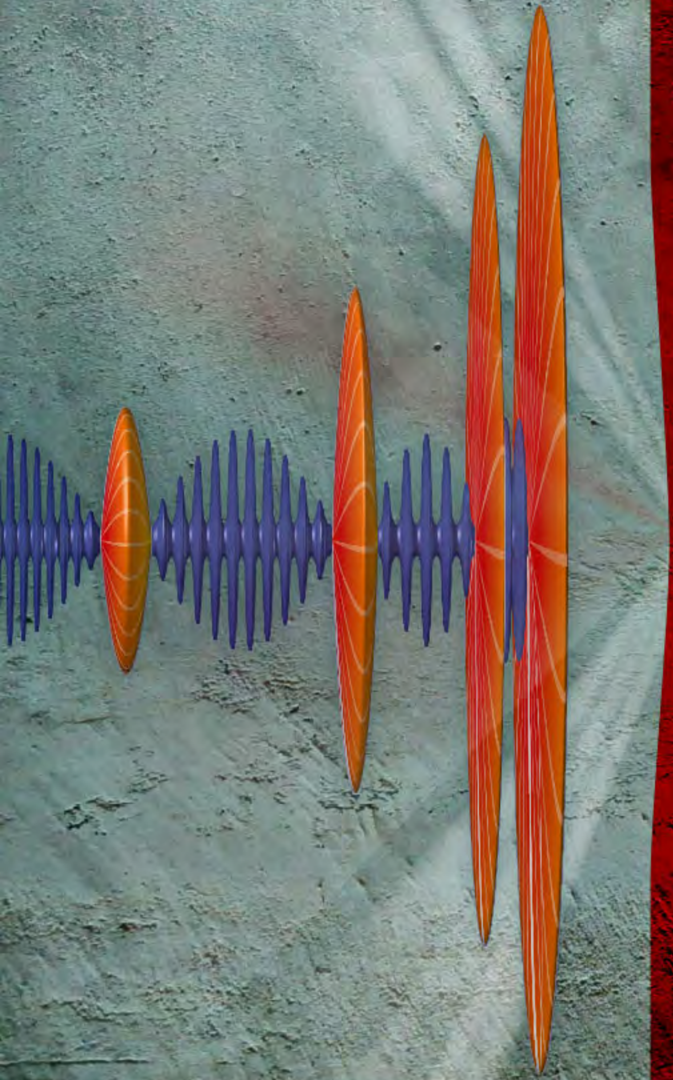
2020 WARNING



Patterns in war dynamics reveal disturbing developments

Ingo Piepers

This book is dedicated to

YOU

The illustration on the cover of the book depicts the first finite-time singularity dynamic (1495-1945) as a 'turbine' consisting of four accelerating cycles that propels the System to the next level of social integration and expansion. Increasingly severe systemic wars, and non-systemic wars during relatively stable periods, are respectively shown as red and blue discs.

Colofon

2020: WARning

This study should be referred to as follows:
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If today, thinking it over calmly, we wonder why Europe went to war in 1914, there is no sensible reason to be found, nor even any real occasion for the war. There were no ideas involved, it was not merely about drawing minor borderlines; I can explain it only, thinking of that excess of power, by seeing it as a tragic consequence of the internal dynamism that had built up during those forty years of peace, and now demanded release.

Stefan Zweig, The World of Yesterday, 1942

Preface

This book, *2020: Warning* contains a study with the title: *Social integration and expansion in anarchistic systems: How connectivity and our urge to survive determine and shape the war dynamics and the development of the System* we live in. The study consists of six parts: Part I 'Theory', Part II 'Perspectives', Part III 'Statements', Part IV 'Assessment and Prediction', Part V 'Confrontation' and Part VI 'Theories, Terms and Definitions'.

In this preface, I discuss several main findings of the study, and this preface serves as a bridge to the actual scientific study.

The main results of this study

The conclusions of this study are very straightforward: the system we live in obeys physical laws and is highly deterministic in nature. The system produced - and still produces - two types of wars: systemic and non-systemic wars. Systemic wars qualify as 'world wars' and 'rebalance' the system, whereas non-systemic wars are normally smaller in size and only have limited effects. By means of wars the system releases tensions, that can be understood as free energy that must be put to work, in order to comply with physical laws. This study shows that systemic wars are periodically necessary in anarchistic systems to rebalance relationships among states and to implement upgraded international orders that provide - at least temporarily - relative stability and allow for further (e.g., population) growth.

The system started producing regularities in its war dynamics around 1495, when Europe - the continent that would become the core of the system - became sufficiently connected.

From 1495-1945, the system developed a first so-called self-organized finite-time singularity dynamic that ultimately resulted in a phase transition through the fourth systemic war (the Second World War, 1939-1945). The Second World War (the fourth systemic war) marks the end, and the start of respectively the first and second finite-time singularity dynamic.

The system resumed non-systemic war dynamics following the Second World War. When in 1989 the Cold War ended, the system resumed so-called 'chaotic' war dynamics. The chaotic nature of non-systemic war dynamics explains why these wars are highly unpredictable in many aspects, e.g., timing and duration, despite their deterministic nature. This study shows that the second singularity dynamic will likely also consist of four accelerating cycles.

Based on extensive data analysis and new insights into the workings of complex systems and networks, this study predicts that the system we live in will produce a next systemic war - that is a world war - around 2020. The study shows that the international system is currently 'charging' for a next systemic war. Systemic wars are instrumental in rebalancing the system and in producing relatively stable periods that allow for collective survival and (e.g., population) growth.

The charging of the system - the accumulation of tensions - can be observed and felt in the system. The number of unresolved issues grows, and unresolved issues and tensions currently accumulate in the system. These tensions can be understood as free energy. Physical laws dictate that free energy will periodically be put to work by means of systemic war, to implement an upgraded order that again allows for a lower energy state (relative stability) of the system.

In this study, I provide overwhelming evidence for these far-reaching statements and also proof that the system in which we live is a highly deterministic and predictive system. We are integral parts of this system, that produces war dynamics through our collective/shared efforts to survive in an anarchistic system that is organized into sovereign states. This study shows that humankind's urge to survive in anarchistic systems and increasing connectivity (population growth) result in 'free energy' - tensions - that in fact drives the war dynamics and develops the system. This study also suggests, that as a consequence of the increasing connectivity of the system, systemic wars will become increasingly severe, and as a consequence potentially cause irreparable damage not only to humankind and its social structures but also to our climate.

The war dynamics of the system are however not without purpose. The finite-time singularity dynamics are instrumental in a process of social integration and expansion in the system and facilitated population growth in Europe from 83 million people in 1495 to 544 million people in 1945.

The regularities I discuss in this study raise the question why these regularities were not discovered in an earlier stage, given the extensive efforts of historians to that end. The reasons that the regularities in war dynamics and the development of the system were not discovered at an earlier stage are simple: historians and social scientists typically focused on the short term or isolated incidents and developments. The regularities that are presented in this study can only be identified from a long-term perspective and furthermore require the use of recent insight into the workings of complex systems and networks. The fact that 'smaller' wars (non-systemic wars) had become increasingly sparse during the 19th and 20th centuries and that the First and Second World Wars (both systemic wars) were wrongly viewed as abnormalities has put us, including historians and other scientists, on the wrong track.

The fact that smaller wars (non-systemic wars during relatively stable periods) have become increasingly sparse during the period 1495-1945 is an effect that can be attributed to the increasing connectivity of the system. This increasing connectivity gradually suppressed smaller wars and simultaneously forced the system to release tensions through increasingly severe and frequent systemic wars.

Furthermore, a 'distortion' of the non-systemic war dynamics of the system during the period 1657-1763 contributed to the inability of historians to identify regularities in war dynamics. These distortions can now be identified and also be explained by using insights into the workings of physical systems.

The study is the outcome of a journey

The study that I present in this book is based on a combination of personal experience - i.e., participation in war (Sarajevo, 1995) as part of the Rapid Reaction Force of the United Nations, and a long-term stay in a country (Java, Indonesia) with a different culture - and extensive study of both war dynamics and the development of the system in which we live.

The experience of war and its effects, and the first-hand observation of humankind's ability to inflict massive destruction and suffering, made me even more aware that we must not and cannot accept such destructive dynamics and behavior from the human and ethical points of view. Moreover, these dynamics cannot be accepted from a very practical perspective; because of (systemic) war's increasing severity and the unavoidable use of nuclear weapons, war will eventually destroy us.

I refuse to accept living in and being part of a system that dictates and ultimately destroys our future because it forces increasingly destructive wars upon us. I do not want my own children my own children, Mike, Timo and Lisa - or other children in our world - to be confronted with war. We are obligated to stop these dynamics and to work cooperatively on a shared future.

Approximately twenty years ago, I became increasingly intrigued by whether the international system qualifies as a complex system that produces self-organized dynamics and structures that show regularities, that then can be used to predict war dynamics and obtain better control of these dynamics. This interest resulted in a Ph.D. thesis (2006) whose outcome was promising but still inconclusive.

The main conclusions of this initial research were that the international system (1) shows the characteristics of a so-called self-organized critical system, (2) develops as a punctuated equilibrium dynamic, (3) periodically experiences fundamental changes, (4) becomes increasingly stable over time, and (5) is normally chaotic in nature. These initial assumptions (conclusions) turned out to be quite accurate but not complete, which this study shows.

In the following years, I continued to study war and the development of the system. Several years ago, I committed myself again to research, which resulted in this study/report.

Two factors made it possible to make the discoveries that I present and discuss in this study. The first factor is that new insight into the workings of complex systems and networks can also be applied to the dynamics and development of the system. The second and most important factor was my long-term stay on the island of Java, Indonesia, in close contact with local people and communities.

This stay allowed me to study a different culture, different social structures and the dynamics that they generate, and it forced me to challenge the assumptions that underlie my thinking.

I am very grateful for the hospitality that I always encountered in Java, the insight that Java provided, and the sincere friendships that I established during my stay. This stay and the people I met reinforced my conviction that diversity is essential for our collective survival, simply because it provides us with new insight and solutions to problems that seem unsolvable or that are new to us. Diversity, including cultural and religious diversity, is a prerequisite to our collective survival and the ability to find solutions to the challenges that we encounter. Humankind is just beginning.

We can no longer escape our responsibility.

Initially, I wrote this study for the scientific community; the study is in many respects technical and understandably somewhat complex. What adds to its complexity - and probably also to the skepticism of the scientific community - is that this study does not fit within a typical scientific domain. In this study, I apply concepts related to theoretical physics and network and complexity science to historical and social structures and their dynamics; for this reason, the study is new and does not easily fit in a conservative scientific community.

I am aware that that this study will be received with skepticism, as it should, but I urge and challenge scientists to prove me wrong. I am not a prophet who is predicting the end of the world or someone who is inspired by conspiracy theories or vague spiritual signs; to the contrary, the results of the study are hard science.

As I mentioned, during my research I made some (disturbing) discoveries. The disturbing discovery that the system will become critical around 2020, implying systemic war, is the reason I decided to make this study available to the general public in order to create awareness of this unsettling development and to try to prevent a catastrophe. I urge scientists to validate or falsify the discoveries presented in this study, and politicians to take responsible action.

The discovery that the system is now charging - about to become critical - is understandably a disturbing discovery, but maybe an even more revealing insight that this study provides is that our system is a highly deterministic system, and we have until now been unable to recognize this. This lack of recognition indicates a collective human ability to deceive ourselves. Deterministic laws shape and determine war dynamics, and we comply with these requirements without any awareness or distrust. When these laws want us to fight wars - to release tensions and put free energy to work - we comply. By complying, we are not the masters of our destination and future. It is now time to assume control together to ensure our collective survival and to avoid our collective self-destruction.

Because wars, especially world wars, are the outcome of our shared efforts to survive in an anarchistic system (such as the current international system), our shared commitment is also required to prevent war and to collectively develop other methods that do not result in massive destruction and suffering.

Because this study reveals the underlying mechanisms of war dynamics, it is presently possible to prevent war, at least in theory. No longer is it a matter of being unable to achieve the prevention of war by failing to understand the workings of the system. It now has become a matter of being unwilling to achieve this.

Presently it is also possible to build robust international orders that do not collapse; this study provides us with the organizing principles that can achieve this. Until recently the architects of our international orders have built organizational 'structures' (like the United Nations), without being aware of the highly deterministic laws and mechanisms that underlie the system's dynamics. Unsurprisingly, these international orders always collapsed and required systemic wars to re-establish order. International theorists can be compared with architects who built skyscrapers without being aware of the existence of gravity and its effects. Now collapse of international orders can be avoided, and it is our responsibility to achieve this.

I would like to thank especially three persons for their crucial support during the making of this book: Ida Suryani, my partner for her continuous support and patience, Jaap Wolters who took charge of the lay-out of the book, and provided me with very valuable communication advise, and Bert Laker for his support in building the website and ensuring the book's digital distribution.

I dedicate this study to you, for the very simple reason that you - along with myself - are part of the war dynamics that the system produces. However, as this study also shows, each one of us is also part of the solution to this self-destructive dynamic: It is now time to act.

Ingo Piepers

Borobudur, Java, Indonesia
Amsterdam, The Netherlands
September 2016

Introduction

Major findings

Until now, we have been unaware of the deterministic nature of war dynamics and the development of the System. This study not only reveals the deterministic nature of the System and its dynamics but also demonstrates that a deeper – and simple – order underlies the System: The 'chaotic' and 'complex' dynamics of the System result because the System obeys certain physical laws".

It is fair to say that 'history', historical research methods, international relations theory, and similar academic disciplines lack organizing principles and a scientific framework. Until now, these 'sciences' were concerned only with contingent dynamics and remained unaware of the existence and impact of an underlying highly deterministic domain.

In this study, I show that the System periodically becomes critical for short intervals of time and produces systemic wars to release tensions that have built up within it. These tensions are equivalent to energy – to which physical laws apply. In contradistinction to what we have assumed until now, this study reveals that the System – and specifically its dynamics and development – is highly deterministic in nature.

States and their populations constitute an anarchistic System. Anarchistic Systems, this study shows, regulate energy (tension) production and its use by means of self-organized finite-time singularity dynamics accompanied by accelerating cycles that are the 'products' of the physical laws that apply to the System.

Finite-time singularity dynamics ensure an optimal balance between order and disorder in the anarchistic System and ensure its performance and evolvability. The performance of the System refers to its ability to fulfill the basic requirements of states and their populations, whereas evolvability refers to the System's ability to make timely adjustments to its order (organization) in response to changed circumstances and conditions. In so doing, singularity dynamics enable population growth, while this population growth simultaneously further drives the development and unfolding of singularity dynamics.

Because of their path dependent dynamics and lock-in on war, singularity dynamics not only constitute 'war traps' but also are instrumental in implementing upgraded orders in the System. Successive upgraded orders help implement increasingly comprehensive organizational arrangements that underpin successive international orders. Singularity dynamics are thus instrumental in the long-term process of social integration and expansion (SIE).

Three shortcomings in particular have frustrated our ability to fathom the real nature of the System: (1) the chaotic nature of non-systemic wars; (2) that the (accelerating) cycles that accompany finite-time singularity dynamics are the natural units of analysis of the System that expose the System's properties and their very regular development; and (3) the distortion of the System's war dynamics during two 'exceptional periods'.

The majority of wars in the System, which includes all wars except for four systemic wars, are non-systemic and mainly chaotic in nature. Chaotic war dynamics are intrinsically unpredictable; regularities cannot be identified/observed if this simple fact is not taken into consideration.

However, four wars that the System has produced since 1495 were systemic in nature and highly predictable. Systemic wars not only define the long-term development of the System in the direction of increasing levels of integration but also accelerate the cycles that accompany finite-time singularity dynamics.

As I explain herein, systemic wars are produced at an accelerating rate, which is in line with the physical laws that apply. Each cycle consists of a relatively long, relatively stable period in which the System produces non-systemic wars, which is followed by a relatively short critical period (systemic war). These cycles constitute the natural units of analysis of the System, and their properties (also) reveal the deterministic nature of the System and the System's very regular (and predictable) dynamics.

During two 'exceptional periods' (1657-1763 and 1953-1989), as I have defined them, the war dynamics of the System were temporarily disturbed. During both of these periods, the intense rivalries between two Great Powers (Britain and France in the earlier period and the United States and the Soviet Union in the later period) decreased the number of degrees of freedom in the System to two, thus compromising the ability of the System to produce chaotic non-systemic war dynamics.

The insights I present and discuss in this study are new, and they offer us the opportunity to assume control of the war dynamics of the System.

This study shows that the System will again become critical around the year 2020 and will thus produce a systemic war to put the energy (tensions and unresolved issues) in the System that has accumulated – and that is accumulating now – to work to implement an upgraded order that again fosters a lower energy state and a new, relatively stable period.

The study suggests that the second finite-time singularity dynamic is accompanied by four accelerating cycles and will reach the critical connectivity threshold and produce a phase transition in approximately 2185.

Systemic wars – world wars as we call them – will necessarily (because of the physical laws that apply) become increasingly severe and intense and will cause immense human suffering and destruction. Application of the destructive energy that is required to rebalance the System could result in collective self-destruction, not only because of the scale of human suffering and destruction but also because of the damage that will be inflicted on our climate if nuclear weapons are deployed, as can be expected.

The war dynamics of the System are self-organized; in other words, they are the outcome of multiple interactions between states and their populations, which indicates that we are all not only part of the problem but also part of its solution. This study provides us with the (basis of the) knowledge to prevent these war dynamics and to develop means other than war that can be employed to periodically rebalance the System.

We should realize that current efforts to prevent and mitigate the effects of climate change – which is also vital for our survival and well-being – could well become superfluous if we do not effectively take control of the potentially self-destructive war trap we collectively produce.

The regularities and mechanisms I expose in this study can contribute to a fundamental change. However, they are only a start: there is much (more) to discover, to understand, and to improve in the framework I present in this study. This study makes it possible to develop effective strategies to prevent war and to design international orders that can avoid war, at least in theory. I hope this study provides us with the necessary insights and awareness to make fundamental changes to our System and to our behavior.

Our efforts to achieve our objectives will reveal whether we can exercise control over our free will and our collective destination, or it will show that we continue to be obedient followers of physical laws, which will again set a war trap for us.

Methods

To identify the consistencies and 'construct' the theory that I present and discuss in this study, I made use of insights into the operation of networks and complex systems, in addition to concepts from theoretical physics (criticality, phase transitions, and others).

By applying an iterative process of 'construction' and empirical testing, a consistent and relatively simple theory emerged: The System represents the production, release and use of energy, to which physical laws apply; the System and its dynamics and development are highly deterministic in nature; and physical laws 'force' the System to implement upgraded orders, which then enable (further) integration.

The System and the finite-time singularity dynamics accompanied by the cycles it produces are instrumental in fulfilling the basic requirements of populations that have 'clustered' in states (also a product of the first finite-time singularity) and ensure their collective survival. Through singularity dynamics, anarchistic Systems enable(d) population growth, which then further power(ed) the development and unfolding of the singularity dynamic.

The framework/theory also allows for prediction, but the accuracy of its predictions must still be tested: I expect the System to become critical again in approximately 2020 and to produce a systemic war to implement an upgraded order and to ensure compliance with the physical laws that apply to the System.

In this study, I make particular use of the war data provided by Levy (38), which are complemented by a number of other data sets (25), (52), (59).

The results I present in this study and the theory I develop are just a beginning; more research is required to confirm or refute the research results I present and discuss in this study.

I am convinced that the results of this study (finally) give us the opportunity to fundamentally improve our understanding of the workings of the System, its dynamics, and our role in them and to develop policies to avoid becoming caught up again in an accelerating war trap that could lead to our collective destruction.

However, this problem – as is the case with (the effects of) climate change – can be solved only with the support of everyone in the System; for that reason, I dedicate this study to 'everyone'.

Presentation

It is a challenge (at least for me) to explain these new insights and the theoretical framework I developed in this study by means of iteration not only because it is a fundamentally different – 'new' – approach to studying the dynamics and development of the System but also because of the far-reaching and new insights this study provides. It is evident that a paradigm shift is now necessary (and possible).

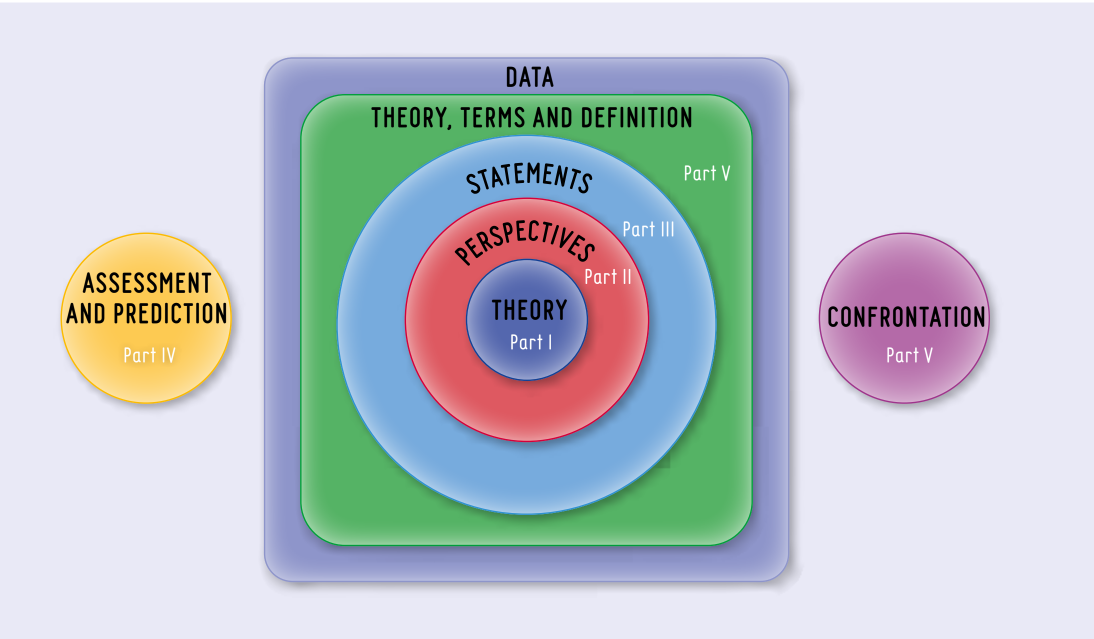


Figure 1 *This figure shows the structure of this study and its presentation.*

In the first part (*'Theory'*), I present the main components of the theory. In so doing, I present the theory by means of a number of related 'statements' that each addresses a particular point/subject.

In Part II (*'Perspectives'*), I discuss fifteen different 'perspectives' that address different aspects and components of the System. These perspectives are complementary.

In Part III ('*Statements*'), I discuss 323 statements; the statements address particular issues related to the theory. These statements are grouped in twenty subjects. The Statements and the subjects overlap to a degree. To arrive at a better understanding of the functioning of the System, in a number of cases I address particular issues from (only slightly) different perspectives.

The next section – Part IV ('*Assessment and Prediction*') – is specifically dedicated to assessing the current condition of the System and to predicting its dynamics and development over both the short and long terms. Part IV represents a combination of theory and statements related to assessments and prediction.

In Part V ('*Theory, Terms and Definitions*'), I discuss some theoretical issues associated with networks, complex systems and theoretical physics that are related to and/or apply to the System and its dynamics. I also provide a list of the terms and definitions that I introduce in this study as a reference.

In Part VI ('*Confrontation*'), I challenge historical research and certain dogmas in international relations by applying the theory developed in this study. This confrontation reveals a number of fundamental shortcomings in both the historical research (methods) and in international relations theory that must be resolved to ensure that they are of use and that they provide proper policy advice.

In Part VII, the data I used in this research are presented.

Summary

During the 1495-1945 period, the anarchistic System produced the first self-organized finite-time singularity dynamic, which was accompanied by four accelerating cycles; each cycle consisted of a relatively stable period (international order) followed by a relatively short critical period (systemic war). The System is presently in the first cycle of the second finite-time singularity dynamic (1945-...), which will then also be accompanied by accelerating cycles.

During relatively stable periods, the anarchistic System produces non-systemic wars (non-systemic energy releases). Because of their (normally) chaotic nature, non-systemic wars are intrinsically unpredictable; their impact is 'local'. The chaotic nature of non-systemic wars can be attributed to a third degree of freedom in the System; this third degree of freedom ensures a certain inhibition in the size and severity of non-systemic wars, as this study shows. The number of degrees of freedom in the System – and the nature of its non-systemic war dynamics – is determined by the intensities of rivalries between contemporaneous Great Powers.

Certain properties of systemic wars – and the criticality of the anarchistic System that the systemic wars imply – are highly predictable. These properties include the start time, duration and amount of destructive energy that is deployed, and these properties obey physical laws that apply to the System and develop with remarkable regularity. By means of systemic wars, the System implements upgraded orders that enable lower energy states and 'new' relatively stable periods, which is consistent with the requirements of the second law of thermodynamics.

Finite-time singularity dynamics are instrumental in the SIE process in the anarchistic System. During the 1495-1945 period, Europe – the core of the System – developed from a sizeable collection of loosely connected and diverse units into a highly integrated system of 25-30 highly standardized states with fractal structures. Simultaneous with the integration of the core of the anarchistic System via the first finite-time singularity dynamic, core states also moved into non-core territories to expand their political control, power and influence. The integration of the core and the expansion to the non-core were synchronized and mutually reinforcing dynamics.

In 1939, the core of the anarchistic System (Europe) reached its critical connectivity threshold at which point it produced infinite amounts of free energy (tensions) and consequently collapsed. In 1941, the critical core connected to vulnerable issue clusters and war dynamics in the non-core and became critical on a global scale.

In response, through the fourth systemic war (the Second World War, 1939-1945), the System produced a dual-phase transition. By means of this dual-phase transition, two dedicated non-anarchistic hierarchies and a first global order were simultaneously implemented both in the core of the System (Europe) and on a global scale in the System to ensure compliance with the second law of thermodynamics.

In 1945, the now (global) anarchistic System produced a second finite-time

singularity (1945-...). The second singularity dynamic is now in its first cycle. Both singularity dynamics are instrumental in the long-term SIE process in the anarchistic System. This study suggests that eventually (around 2185) the second finite-time singularity dynamic will reach its critical connectivity threshold – its anarchistic end state – and collapse, producing a phase transition to a global non-anarchistic hierarchy.

The intrinsic incompatibility between increasing connectivity and security in anarchistic systems causes the System to produce free energy (tensions). The connectivity of the System, which is a function of its population size, is the driver (control parameter) of the System. Because of the rate of growth of the population, and as a consequence of the System's connectivity, the anarchistic System produces free energy at an accelerating rate.

The second law of thermodynamics and a number of other deterministic laws and mechanisms apply to the free energy produced by the System. To ensure consistency with the second law of thermodynamics, the free energy that is produced is put to work during critical periods through systemic wars to implement upgraded orders that enable lower energy states – relative stability – in the System.

The requirement to implement upgraded orders at an accelerating rate to ensure consistency with the second law of thermodynamics facilitates a process of integration in the System. Each upgraded order requires the implementation of increasingly comprehensive arrangements that underpin successive international orders to ensure compliance. This dynamic is at the heart of the SIE process.

Free energy can and does accumulate in the System, which will cause the System to become critical and produce systemic wars; this free energy typically accumulates during high-connectivity regimes during the relatively stable periods of cycles. As I mentioned, each cycle consists of a relatively stable period that is followed by a systemic war (critical period).

High-connectivity regimes in combination with chaotic, non-systemic war dynamics are preconditions for the System to 'charge' itself – to build up sufficient free energy (tensions) – to the point at which it becomes critical, produces systemic wars, and upgrades its order.

A high-connectivity regime is one of two types of regimes that can be distinguished during the lifespan of relatively stable periods. Initially, following a systemic war, relatively stable periods are associated with low-connectivity regimes. During low-connectivity regimes, the sizes of non-systemic wars remain restricted by the limited connectivity of the issue network of the System. However, after the relatively stable period reaches a tipping point, the System is in a high-connectivity regime. During high-connectivity regimes, a 'connectivity/local stability effect' allows for the accumulation of free energy in the System, leading to a temporary metastable configuration.

During high-connectivity regimes, free energy (tension) is stored in the System instead of being released, and it crystallizes in vulnerable issue clusters with fractal structures. These vulnerable issue clusters consist of unresolved and new issues and their accompanying tensions. The moment these vulnerable issue clusters percolate through the System, the System becomes critical, and, as a consequence, it becomes highly susceptible to perturbations. Activation of the percolated vulnerable issue clusters produces a systemic war (systemic energy release). During the systemic war, the accumulated free energy is released and put to work to upgrade the System's order. The upgraded order then (again) enables a lower energy state – a period of relative stability – in the System.

Using singularity dynamics, the anarchistic System balances its order and disorder to ensure the System's performance (its ability to fulfill the basic requirements of uneven states in the anarchistic System) and its evolvability (its ability to adapt in a timely manner to the increased connectivity of the System and the higher levels of free energy (tensions) by implementing upgraded orders through systemic wars).

This study shows that finite-time singularity dynamics and states' population growth within the anarchistic System generate a self-reinforcing (positive feedback) mechanism.

The performance and evolvability of the singularity dynamic enables the balanced fulfillment of the basic requirements of states in the anarchistic System and (in so doing) the growth of their populations. This population growth then results in the increasing connectivity of the anarchistic System and in the accelerating production of free energy because of the intrinsic incompatibility of connectivity and security in anarchistic systems. Population growth ensures the continuous 'powering' and unfolding of the singularity dynamic, while the unfolding of the singularity dynamic ensures population growth.

To ensure consistency with the second law of thermodynamics, higher levels of free energy (tensions) require higher levels of order, which means that the singularity dynamics are instrumental in the SIE process.

The acceleration of the finite-time singularity dynamic accompanied by four accelerating cycles during the 1495-1945 period and its eventual collapse in 1939 show that over time, the core of the System (Europe) became increasingly unstable. This study reveals that the increasing instability of the core of the anarchistic System developed hand-in-hand with the linearly increasing robustness, fragility, and structural stability of successive relatively stable periods (international orders) of the System.

As I mentioned, the non-systemic war dynamics of the System are normally chaotic in nature. However, during two periods of time, the chaotic non-systemic war dynamics of the System were distorted.

During the lifespan of the first finite-time singularity dynamic (1495-1945), the chaotic, non-systemic war dynamics of the System were temporarily distorted during the 1657-1763 period, which is designated as the first exceptional period. A distortion – abnormal, non-systemic war dynamics – also appeared during a second exceptional period that occurred from 1953 until 1989 during the first cycle of the second singularity dynamic (1945-...).

In both cases, abnormal, non-chaotic war dynamics can be attributed to a temporary reduction in the degrees of freedom (n) of the anarchistic System, as a consequence of the intense rivalry between Britain and France (first exceptional period) and between the United States and the Soviet Union (second exceptional period). Abnormal war dynamics lack the intrinsic inhibition of chaotic war dynamics, which are ‘governed’ by three degrees of freedom.

Because of a temporary reduction in the System’s degrees of freedom, the System produced a series of hyper-excited, periodic, non-systemic war dynamics during the first exceptional period (1657-1763) that included two regular subcycles. During the second exceptional period (1953-1989), the System produced highly subdued, non-systemic war dynamics.

This study shows that the hyper-excited war dynamics during the first exceptional period (1657-1763) disturbed the development of the second cycle (1648-1815) of the finite-time singularity dynamic, leading to a delay in its development, energy-inefficiencies, and a distortion in the energy release distribution of the second cycle.

Because of hyper-excited, non-systemic war dynamics during the first exceptional period, a series of non-systemic wars was exceptionally extreme, lacking a balancing third degree of freedom. These extreme dynamics caused a delay in the unfolding of the first finite-time singularity dynamic, and energy inefficiencies.

At this point in time, a second singularity dynamic (which began in 1945 following the dual-phase transition) is now unfolding in the System; the second singularity dynamic is thus now in its first cycle. The size development of successive non-systemic wars demonstrates that the current relatively stable period (assuming that the database is correct) reached its tipping point in 2011 and is in a high-connectivity regime. Furthermore, the properties of non-systemic wars in phase state show that in 1989 (following the second exceptional period, 1953-1989), the System resumed chaotic, non-systemic war dynamics. Thus, the preconditions for the System to charge for the next systemic war have been met: The System is in a high-connectivity regime, and (chaotic) non-systemic wars are decreasing in size because of the connectivity/local stability-effect. When the properties of the first finite-time singularity dynamic are used as a reference, I find that the System will again become critical by approximately 2020 and will produce a systemic war as a consequence.

By means of the next (fifth) systemic war, the System will put the free energy (tensions) that is now accumulating in the System to work to implement an upgraded order that (again) enables a lower energy state – a relatively stable period – in the System.

The observation that the war dynamics and the System’s development are highly deterministic in nature reveals fundamental shortcomings in our understanding of both the System and its dynamics in terms of our historical research (methods) and in terms of the ‘role’ we play in this System.

PART I

THEORY

Peace cannot be kept by force;

it can only be achieved by understanding

Albert Einstein

Introduction

In this section, I present the theory behind "*Social Integration and Expansion in Anarchistic Systems: How connectivity and our urge to survive determine and shape the war dynamics and development of the System*". I present the theory in the form of 26 related statements.

The theory of social integration and expansion in anarchistic systems in 26 statements	
Statement	Subject
1	Finite-time singularity dynamics
2	Constancy
3	A theoretical model of an undistorted first finite-time singularity dynamic
4	Systemic and non-systemic wars
5	Physical laws
6	Optimum order
7	Four types of (closely related) dynamics
8	Cycles
9	Low- and high-connectivity regimes of cycles
10	Properties of the System
11	Anarchistic end state
12	Damping oscillations
13	Three types of networks
14	Delayed responses
15	A shift in release ratios of cycles
16	Integration
17	The powerful-become-more-powerful effect
18	Charging facilitated by metastability
19	Preconditions for criticality and systemic war
20	Seven types of change
21	Social integration and expansion (SIE)
22	The 'law of SIE'
23	Assessment of the condition of the current international order
24	Critical size of non-systemic wars
25	Not-so-free will
26	The need for a paradigm shift

Table 1 *This table provides an overview of the 24 statements that can be considered the core of the theory of social integration and expansion in anarchistic systems.*

Statements

001 During the 1495-1945 period, the anarchistic System produced the first self-organized, finite-time singularity dynamic, which was accompanied by four accelerating cycles. In 1939, the anarchistic System reached the critical connectivity threshold and consequently collapsed. In response, the System produced via the fourth systemic war (the Second World War, 1939-1945) a dual-phase transition. In 1945, the now (global) System began a second finite-time singularity (1945-…), which is now unfolding and in its first cycle. Both of the singularity dynamics are instrumental in the long-term SIE process.

Over time, humanity has increasingly congregated in larger 'units' – social systems – to ensure its survival and the fulfillment of people's basic requirements; population growth and the opportunities to leverage economies of scope and scale are the drivers of this process. Over time, the social systems that were formed became larger and more integrated. This SIE process began by extending families and then produced tribes; city-states, which eventually (during the 1495-1945 period) 'crystallized' into states and federations of states. This SIE process is still unfolding.

At approximately 1500 A.D., the 'units' that had formed in Europe became sufficiently connected to develop into a system. This System was (and still is) anarchistic in nature.

During the 1495-1945 period, the units in the System developed the (first) self-organized finite-time singularity dynamic, which was accompanied by four accelerating cycles.

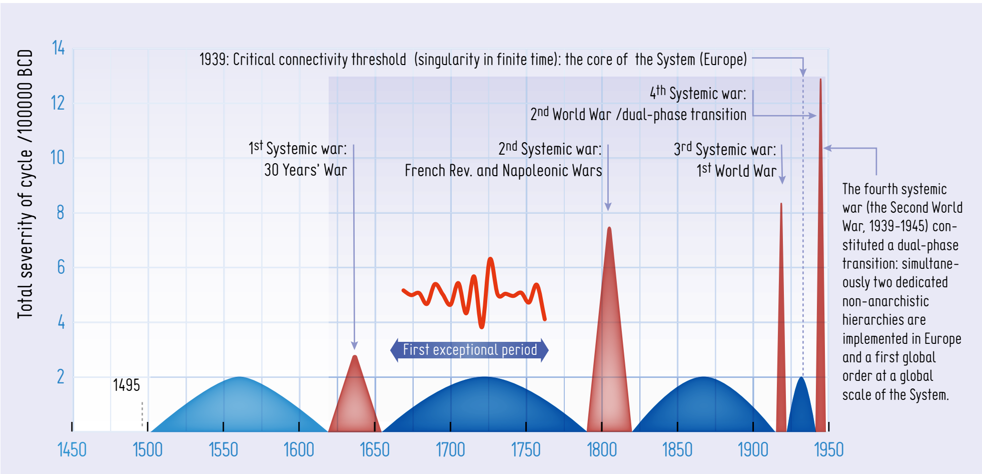


Figure 2 *This figure shows the finite-time singularity dynamic accompanied by four accelerating cycles, the anarchistic System produced during the period 1495-1945.*

At the inception of the singularity dynamic in 1495, the first finite-time singularity dynamic was instrumental in the transformation of hundreds of loosely connected and diverse units in Europe into approximately 25-30 highly standardized and highly connected states in 1939.

In 1939, 'Europe', had developed into the core of the expanding System, had reached the critical connectivity threshold, and had produced 'infinite' amounts of tensions (free energy) as a consequence; in response, the anarchistic System produced a dual-phase transition by means of the fourth systemic war (the Second World War, 1939-1945). The phase transition resulted in the simultaneous implementation of two dedicated, non-anarchistic hierarchies in Europe (the core of the System) and the first global order (and order on a global scale) in the System.

Following the fourth systemic war, the (global) anarchistic System started a second finite-time singularity dynamic (1945-...), which has also been accompanied by a number of accelerating cycles, I assume. The second finite-time singularity dynamic is now in its first cycle.

The connectivity growth of the System – a consequence of population growth as well as the longer average lifespans of humans and increasing levels of prosperity – is the main driver of both of the finite-time singularity dynamics. The population growth of states in an anarchistic System is not without consequences. This study shows that connectivity (growth) and security are intrinsically incompatible in anarchistic systems.

This intrinsic incompatibility results in the production of free energy – tensions – in the anarchistic system. Because of the rate of growth of the population, tensions (free energy) were (and still are) produced at an accelerating and thus unsustainable rate.

Physical laws, including the second law of thermodynamics, apply to the free energy (tensions) that was (and still is) produced by the System and to the dynamics that the System then produces. The second law of thermodynamics 'demands' that free energy in systems be put to work to implement upgraded orders that enable lower energy states in these systems.

In the anarchistic system, the free energy (tensions) that was produced and the physical laws that apply resulted in a highly optimized finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945); during the critical period of each cycle, the tensions (free energy) were put to work through systemic wars.

By means of these (four) systemic wars, states in the anarchistic System collectively designed and implemented upgraded international orders that enabled lower energy states in the System and new relatively stable periods. During these systemic wars, the tensions in the System (free energy) were transformed into destructive energy that was then deployed by armies and navies, among other channels. Wars can be considered energy releases within the anarchistic System. As I discussed above, lower-energy states within the System result in 'new' relatively stable periods (international orders) that allow states in the anarchistic System to fulfill their basic requirements and to grow and develop further.

Because tensions (free energy) were produced at an accelerating rate during the unfolding of the finite-time singularity dynamic as a consequence of population growth, these tensions (free energy) had to be put to work through systemic wars at an accelerating rate to ensure the anarchistic System's compliance with the demands of the second law of thermodynamics.

As this study shows, the growth rate in the severity of the successive systemic wars – the amplitude of the finite-time singularity dynamic – and the accelerating frequencies of the successive cycles (indicated by the accelerating shortening of their lifespans) were completely synchronized: the correlation coefficient is 0.99.

When the anarchistic System reached its critical connectivity threshold in 1939, it produced infinite tensions (infinite amounts of free energy) that had to be put to work at an increasingly rapid rate by means of systemic wars.

In response to this unsustainable requirement, the anarchistic System collapsed and produced a dual-phase transition via the fourth systemic war (the Second World War, 1939-1945).

As discussed above, the dual-phase transition led to a simultaneous implementation of two dedicated, non-anarchistic hierarchies in Europe, which over time (1495-1939) had developed into the core of the expanding System, and in the first global order on the global scale of the anarchistic System. Both of the complementary orders ensured that the System met the demands of the second law of thermodynamics.

Following the dual-phase transition, the globalized anarchistic System then produced a second finite-time singularity dynamic (1945-...), which this study shows is now in the high-connectivity regime of its first cycle.

Although the respective paces of development (i.e., paces of life) of successive cycles of finite-time singularity dynamics differ, their life cycles – their typical behavior during their development – are similar. A cycle typically consists of a relatively stable period (international order) followed by a systemic war.

It is possible to identify two distinct 'regimes' during relatively stable periods (international orders): a low- and a high-connectivity regime, which are distinguished by a tipping point. The moment the international order reaches its tipping point, the (increasing) connectivity of the issue-network of which states are integral parts leads states to become more stable. Because of this 'connectivity/local stability-effect', as I have called it, the size of the non-systemic wars begins to decrease. During high-connectivity regimes, instead of being released, tensions (free energy) that are still produced at an accelerating rate are 'stored' in the System, form 'free energy release deficits', and crystallize in 'underlying' vulnerable issue clusters with fractal structures; these vulnerable issue clusters are clusters of issues that are one step away from being activated into wars.

The moment these vulnerable issue clusters percolate the System, the System becomes critical and produces a systemic war. Systemic wars are thus manifestations of the criticality of the anarchistic System.

Typically, critical systems have a correlation length of one and are for that reason highly susceptible for perturbations; this critical property also enables system-wide communication, coordination, and planning during systemic wars. These typical characteristics of critical systems explain why systemic wars can be triggered by relatively small perturbations; these characteristics also explain why systemic wars are instrumental in (enabling) the collective design and implementation of upgraded orders by states in the anarchistic System.

By 'storing' unresolved issues and tensions during high-connectivity regimes and by their crystallization in vulnerable issue clusters, the System 'charges' itself to become critical, which means that it is able to produce massive energy releases in the form of systemic war.

The System is presently in the high-connectivity regime of the first cycle of the second singularity dynamic, and it is 'charging'.

002 The urge of humanity – of populations of states – to survive, the need to fulfill basic requirements to ensure survival, and the physical laws that apply to the free energy (tensions) that is produced in the System provide constancy in terms of the interactions and dynamics in the System.

Interactions between states in the anarchistic System expose inconsistencies and contradictions in (the fulfillment of) their basic requirements; these inconsistencies and contradictions result in the production of tensions (free energy) in the anarchistic System. Population growth and the increasing interdependence of states contribute not only to the connectivity, interactions and the fulfillment of the basic requirements of states but also to the increasing production of tensions in the anarchistic System. These tensions negatively affect the sense of security of states and their populations in the anarchistic System and are further reinforced – magnified and 'shaped' – by the security dilemmas of and interactive self-fulfilling prophecies between states. I refer to these 'mechanisms' and their dynamics as the intrinsic incompatibility between connectivity and security in anarchistic systems.

During the 1495-1945 period, the collective urge to survive among the populations of states in the anarchistic System – combined with the physical laws that apply to the free energy (tensions) produced as a consequence of the intrinsic incompatibility between connectivity and security – produced a self-organized finite-time singularity dynamic accompanied by four accelerating cycles.

Using the finite-time singularity dynamic and the accompanying four accelerating cycles (1495-1939), order and disorder in the anarchistic System have been balanced, thus maintaining the System's performance (its ability to fulfill the basic requirements of uneven states and their populations in the anarchistic System) and evolvability (the System's timely adaptation to the increased connectivity and tension production in the System).

In four systemic wars (the central components of the first finite-time singularity dynamic), upgraded orders that enabled lower energy states and periods of relative stability were implemented in the System. Relatively stable periods enabled further population growth among the states in the anarchistic System; this further population growth then caused the accelerated growth of connectivity and tension (free energy) production in the System. These tensions 'powered' the development and accelerated unfolding of the finite-time singularity dynamic.

In 1939, when the core of the anarchistic System (Europe) reached its critical connectivity threshold and produced infinite amounts of tensions (free energy), the System experienced a dual-phase transition in response. Through the dual-phase transition – the fourth systemic war (the Second World War, 1939-1945) – two dedicated, non-anarchistic hierarchies and the first global order on a global scale in the System were simultaneously implemented to ensure compliance with the second law of thermodynamics. Through the dual-phase transition, the core (Europe) and non-core of the System merged (1939-1945). In 1945, the (now global) anarchistic System began developing a second finite-time singularity dynamic (1945-...) that is still unfolding.

The urge to survive among states and their populations, the need to fulfill basic requirements, and the physical laws that apply to the free energy (tensions) that is produced in the System also constitute the essence of the second singularity dynamic.

003 A theoretical model of the first finite-time singularity dynamic can serve as a reference to better understand singularity dynamics and can be used to make (better) predictions concerning the second singularity dynamic that is now unfolding.

The first finite-time singularity dynamic, which was accompanied by four accelerating cycles during the 1495-1945 period, was distorted for a number of reasons as it actually unfolded. These distortions include the following: (1) a methodological issue concerning the inception date of the System, (2) the effects of abnormal, non-systemic war dynamics during the first exceptional period (1657-1763), (3) the impact of finite-size effects that cut short the finite-time singularity dynamic, and (4) the globalization of the System during the fourth systemic war (the Second World War, 1939-1945).

To construct a theoretical – undistorted – version of the first finite-time singularity, I applied a number of corrections that I consider relevant: (1) an adjusted System inception date of 1480, implying that six non-systemic wars must be added to the data set, (2) a correction of 13 years for the delay in the development of the second cycle (which was caused by the abnormal war dynamics during the first exceptional period), and (3) a correction to the energy release distribution during the second cycle.

In addition to applying corrections for these specific distortions, I fine-tuned the parameters (properties) of the theoretical finite-time singularity by maximizing the consistency index.

In the figure below, the theoretical – 'undistorted' – model of the first finite-time singularity dynamic is projected 'on top of' the actual first finite-time singularity dynamic.

004 Two fundamentally different types of wars can be distinguished: systemic and non-systemic wars.

During the 1495-1945 period, the anarchistic System produced a finite-time singularity dynamic that was accompanied by four accelerating cycles. When the anarchistic System reached the critical connectivity threshold in 1939, it produced infinite amounts of free energy (tensions) and consequently collapsed. In response, the System produced a dual-phase transition, i.e., the fourth systemic war (the Second World War, 1939-1945). Singularity dynamics are a product of the second law of thermodynamics and a number of other deterministic laws and principles that apply to the free energy (tensions) that was and is produced by the anarchistic System and to the System's dynamics (see also below table).

	Deterministic laws and rules
1	Incompatibility between increasing connectivity and security in anarchistic systems results in the production of free energy (tensions).
2	Connectivity growth is the driver of the System.
3	The second law of thermodynamics applies to the free energy that is produced in the System. A number of 'principles' are closely related to this law, they include the principle that 'free energy will be put to work' and that the 'an order will be implemented that enables a lower energy state of the System'.
4	The System organizes into a network of binary decision nodes with externalities and thresholds.
5	The level of connectivity of the network of issues and states determines if the System is in a low- or high-connectivity regime; the type of regime determines the sizes and frequency of non-systemic wars.
6	Depending on the number of degrees of freedom in the System, its non-systemic war dynamics are chaotic ($n > 2$) or non-chaotic ($n = 2$) in nature.

Table 2 *This table specifies deterministic laws and rules that are necessary for a self-organized singularity dynamic to develop and unfold.*

To meet the demands of the second law of thermodynamics, the anarchistic System put tensions (free energy) to work four times to implement upgraded orders that enabled lower energy states in the System; the free energy was put to work in systemic wars. Systemic wars are indicative of the critical condition of the anarchistic System (at those particular points in time).

Systemic wars defined the four cycles that accompanied the first singularity dynamic; each cycle consisted of a relatively stable period – an international order – that was followed by a systemic war.

Cycles, relatively stable periods and critical periods produced by the anarchistic System through the first finite-time singularity dynamic (1495-1945)				
Cycle	Period	International order / Relatively stable period	Critical period / Systemic war	Name of systemic war
1	1495-1648	1495-1618	1618-1648	Thirty Years' War
2	1648-1815	1648-1792	1792-1815	French Revolutionary and Napoleonic Wars
3	1815-1914	1815-1914	1914-1918	The First World War
4	1918-1945	1918-1939	1939-1945	The Second World War

Table 3 *This table specifies successive cycles, relatively stable periods (international orders) and critical periods (systemic wars) the anarchistic System produced by means of the first finite-time singularity dynamic (1495-1945).*

By definition, systemic wars are system-sized; systemic wars make use of the critical condition of the System. Criticality implies that at that point, the correlation length of the System is 'one'. A correlation length of one not only makes the System highly susceptible for perturbations but also enables system-wide communication, coordination and planning in the System. These critical properties ensure that during systemic wars, states can 'collectively' design and implement upgraded international orders that regulate the interactions between states during the next relatively stable period.

As the development and unfolding of the finite-time singularity dynamic shows, systemic wars are highly predictable; the accelerating frequency of systemic wars can be attributed to the increasing connectivity of the System, a function of its population size (growth).

During relatively stable periods, the anarchistic System produced (and still produces) non-systemic wars; non-systemic wars do not have the same impact as systemic wars and do not result in upgraded orders.

Similarities and differences between systemic and non-systemic wars	
Systemic wars	Non-systemic wars
Deterministic in nature	Deterministic in nature
Define accelerating cycles that accompany a finite-time singularity (1495-1945)	Non-systemic war dynamics are normally chaotic in nature, when the number of degrees of freedom $n > 2$; or periodic or subdued, when $n = 2$, as was the case during the first (1657-1763) and second (1953-1989) exceptional periods, respectively.
Constitute free energy release events	Constitute free energy release events
Are manifestations of criticality. Criticality implies that a system's correlation length spans the System (is one); a correlation length of one enables system-wide communication, coordination, and planning.	Do not represent criticality, and do not have correlation lengths that span the System.

Similarities and differences between systemic and non-systemic wars	
Produce system-wide orders.	Do not produce system-wide orders, and only have local impacts.
Are system-sized.	Are by default not system-sized. Are only system-wide when the System's dynamics are not controlled or constrained by a third degree of freedom as seen during the first exceptional period (1657-1763).
Timing, intensity/severity, and duration are highly predictable.	Are intrinsically unpredictable when n > 2, despite their deterministic nature, because of their high sensitivity for initial conditions. Predictability is increased when n becomes 2, and chaotic non-systemic war dynamics become periodic or subdued in nature.
The frequency and amplitudes of successive systemic wars accelerate at an increasing rate, producing a singularity in finite time.	Their absolute number and frequency decrease linearly during successive relatively stable periods of successive cycles, a trend that can be explained by the increasing robustness – local stabilities of states – in the System.

Table 4 *This table summarizes the similarities and differences between systemic and non-systemic wars.*

Normally, non-systemic war dynamics are chaotic in nature, as I show in this study. Chaotic (war) dynamics are intrinsically unpredictable because of their sensitivity to the initial conditions of the System. However, during the second cycle (1648-1815) of the first singularity dynamic (1495-1945), the 'default' chaotic, non-systemic war dynamics of the System were temporarily distorted; I call this period the first exceptional period (1657-1763). During the first cycle (1945-…) of the second singularity dynamic, the System's non-systemic war dynamics were temporarily distorted during the period that I have designated the second exceptional period (1953-1989).

During both of the exceptional periods, the non-systemic war dynamics were not chaotic but periodic (1657-1763) and highly subdued (1953-1989) in nature. These changes in the nature of non-systemic war dynamics can be attributed to a temporary decrease in the number of degrees of freedom in the System during both periods, which was a consequence of the intense rivalry between Britain and France (first exceptional period) and between the United States and the Soviet Union and the respective hierarchies they controlled (second exceptional period). The increased intensities of these rivalries resulted in a temporary reduction in the number of degrees of freedom (n) in the System from n > 2 (chaotic dynamics) to n = 2 (non-chaotic, periodic and subdued non systemic war dynamics, respectively).

Properties of chaotic and non-chaotic non-systemic war dynamics	
Chaotic	Periodic
Degrees of freedom > 2	Degrees of freedom = 2
Default non-systemic war dynamics	Abnormal non-systemic war dynamics
Intrinsically unpredictable	More regular and more predictable
More constrained in size and severities	More extreme in size and severities in case of periodic non-systemic war dynamics during the first exceptional period (1657-1763), subdued during the second exceptional period (1953-1989)
Contribute to the development of the System towards criticality	Hinder the development of the System towards criticality
Ensure optimality and efficiency	Cause delay and inefficiencies in the unfolding of the singularity dynamic; negatively affect optimality and efficiency

Table 5 *This table shows the different properties of chaotic and abnormal (periodic and subdued) non-systemic war dynamics.*

The analysis shows that periodic, non-systemic war dynamics during the first exceptional period were much more predictable; it is possible to identify two 'identical' subcycles in the non-systemic war dynamics during this period.

The chaotic and periodic war dynamics differ not only in their degree of predictability. The analysis also shows that chaotic war dynamics are more 'restrained' – more balanced – tabthan the more extreme periodic war dynamics, which are 'hyper-excited'. During the first exceptional period, however, the System produced a number of system-sized non-systemic wars that do not qualify as systemic (in contrast to what their size suggests). I argue that non-systemic war dynamics must be chaotic to ensure the 'smooth' development and unfolding of a finite-time singularity dynamic.

These exceptional dynamics are consistent with a 'framework' that applies to systems that make a transition to chaos and, I argue, to systems (as was the case for the System during both exceptional periods) that are the reverse of chaos. Transitions to (and reversals from) chaos are interrupted by periodic windows during which the system produces periodic dynamics. I argue that the doubly periodic non-systemic war dynamics the System produced during the first exceptional period (1657-1763) can be attributed to a periodic window the System temporarily reached because of a decrease in the number of degrees of freedom in the System.

During the unfolding of the first finite-time singularity dynamic (1495-1945), the anarchistic System produced four accelerating and very regular cycles via four systemic wars, as discussed above.

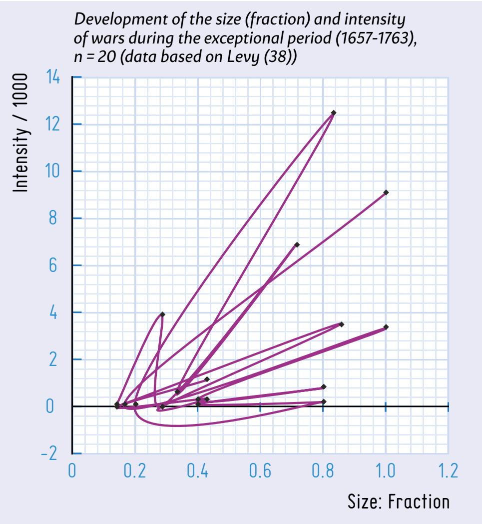


Figure 3
This figure shows trajectories of wars in phase state during the first exceptional period (1657-1763); these trajectories do not orbit (data based on Levy (38))

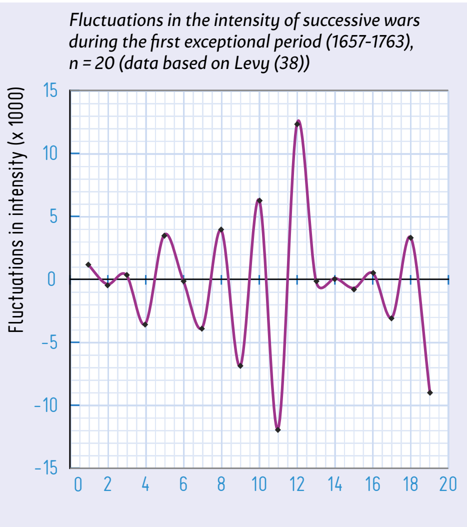
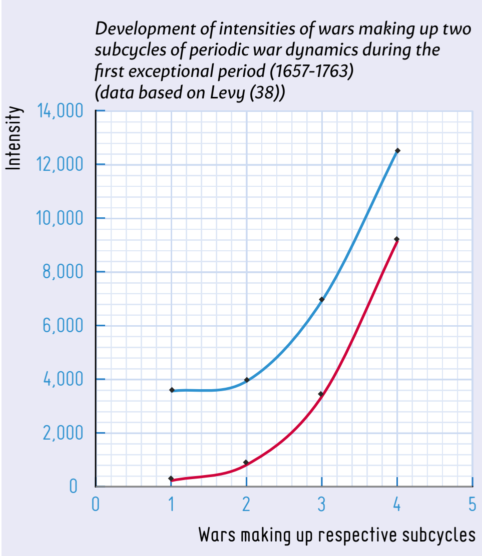


Figure 4
This figure shows fluctuations in the intensities of successive wars during the first exceptional period (1657-1763): (I(t) - I(t+1)).

Intensities of wars making up cycles of periodic war dynamics during the exceptional period (1657-1763) (data based on Levy (38))				
	Cycle 1 (1667-1716)		Cycle 2 (1716-1763)	
	No. Levy	Intensity	No. Levy	Intensity
1	62	3580	71	245
2	65	3954	73	836
3	67	6939	75	3379
4	69	12490	77	9118

Table 6 *In this table the wars that constitute two subcycles are specified (data based on Levy, (38)).*

Figure 5
This figure shows the intensity of wars that make up two subcycles during the periodic war dynamics of the first exceptional period (1657-1763). The first subcycle (1667-1716) is depicted in blue, the second subcycle (1716-1763) in red.



Although chaotic non-systemic wars (as such) were highly unpredictable (except for a number of non-systemic wars during the first exceptional period), their number – and some other properties – developed very regularly during successive cycles. The number and frequency of non-systemic wars during successive cycles decreased linearly, an effect I attribute to the increasing connectivity – robustness – of the System during successive cycles, which is an effect that is closely related to population growth.

Following the collapse of the anarchistic System (in Europe) in 1939 and the dual-phase transition the System produced in response (through the fourth systemic war, the Second World War, 1939-1945), the (now) global System developed a second singularity dynamic (1945-...).

This study suggests that the System is presently in the high-connectivity regime of the first cycle of the second finite-time singularity dynamic. The first cycle (1945-...) also experienced an exceptional period, which spanned the 1953-1989 period. An analysis of the war dynamics during the (second) exceptional period shows that they were subdued; these abnormal – non-chaotic – non-systemic war dynamics can be attributed to the intense rivalry between the United States and the Soviet Union during that period of time (better known as the Cold War). The intense rivalry between the superpowers temporarily reduced the number of degrees of freedom in the System, as was the case during the first exceptional period (1657-1763). When the Eastern hierarchy collapsed in 1989, the System resumed chaotic non-systemic war dynamics, a bifurcation of the System that is also evident in the behavior of the System in phase state.

005 Physical laws apply to the System and its dynamics.

This study shows that physical laws apply to the System and its dynamics.

Laws, mechanisms, and related deterministic dynamics

Laws and mechanisms

Free energy principle: 'free energy will be put to work'. Free energy is produced by the intrinsic incompatibility between increasing connectivity and security; a property of anarchistic systems. This incompatibility, in combination with a number of other characteristics of the System, produced a finite-time singularity accompanied by four accelerating cycles (1495-1945). Connectivity is the driver of the anarchistic System.

Related deterministic dynamics and properties

Related deterministic dynamics and properties of the finite-time singularity accompanied by four accelerating cycles, include: (1) the life span of cycles and their respective components; relatively stable periods and systemic wars, (2) the deterministic nature of non-systemic release events, (3) the timing, duration, and severity of successive systemic wars, (4) the moment when the singularity dynamic reaches a critical connectivity threshold (the singularity in finite time) and a phase transition becomes unavoidable, (5) the nature of the outcome of the phase transition; dedicated non-anarchistic hierarchies in the core of the System.

Laws and mechanisms

Free energy principle: 'implementing upgraded order that enables a lower energy state of the System'.

Related deterministic dynamics and properties

Order in the System is achieved through systemic war. Related deterministic properties include the degree of structural stability, robustness and fragility the upgraded order provides during the relatively stable period that follows the systemic war.

Laws and mechanisms

The number of degrees of freedom determines the nature of the deterministic non-systemic release dynamics (of non-systemic wars).

Related deterministic dynamics and properties

The level of rivalry between states in the System determines the number of degrees of freedom of the System. In case of more than two ($n > 2$) degrees of freedom, the nature of the deterministic non-systemic release events is chaotic, implying intrinsic unpredictability of the size, severity, and timing of these events. In case of $n = 2$, the deterministic non-systemic energy releases are periodic and thus more regular and predictable (during the first exceptional period, 1657-1763), or subdued (during the second exceptional period, 1953-1989). In periodic conditions, the System lacks mechanisms that restrain and control the energy level of the System ('intrinsic inhibition'); a third degree of freedom introduces chaotic dynamics and provides such a mechanism. The System becomes hyper-excited during $n = 2$ conditions and produces release events that release high levels of free energy.

Chaotic conditions ($n > 2$) during relatively stable periods are a prerequisite for the System to become critical, produce a systemic war and upgrade its order to allow for a lower energy state of the System.

Laws, mechanisms, and related deterministic dynamics	
Laws and mechanisms A high-connectivity effect producing local stability and a free energy release deficit.	
	Related deterministic dynamics and properties *During the life span of relatively stable periods, at a tipping point the System reaches a high-connectivity regime. During high-connectivity regimes that typically precede critical periods (systemic wars), increasing connectivity implies increasing local stability of the nodes (states) of the System, resulting in a decrease in the size of non-systemic release events. The high-connectivity and (resulting) local stability allow for the build-up of free energy in the System and the formation of vulnerable issue clusters with fractal structures. The free energy release deficit and the percolation of vulnerable issue clusters are prerequisites for the System to become critical, produce systemic wars, and implement upgraded orders.*
Laws and mechanisms Connectivity effects	
	Related deterministic dynamics and properties *Apart from the high-connectivity effect, connectivity growth has a number of related deterministic effects, including: (1) an increase in the pace of life of the System, (2) an accelerating frequency of systemic wars, (3) an accelerating growth rate of the free energy that is produced and will be released by successive systemic release events (systemic wars), and an increase in the (4) structural stability, (5) robustness, and (6) fragility of the System.*

Table 7 *This table shows the relationship between laws and mechanisms that apply to the System, and the deterministic dynamics and properties they produce in the System.*

The laws and mechanisms that apply to the free energy (tensions) produced by the System produced two finite-time singularity dynamics during the 1495-1945 and 1945-2187 periods that were (are) accompanied by accelerating cycles.

The second law of thermodynamics played (and still plays) a dominant role in the production and shaping of both finite-time singularity dynamics, although other laws and mechanisms were also (and are) indispensable.

The System's compliance with the second law of thermodynamics mandates that the free energy that is produced is put to work to implement 'upgraded orders' that enable lower energy states in the System. In anarchistic systems, (increasing) connectivity and security are intrinsically incompatible, which results in the production of tensions (free energy). The tensions (free energy) that build up in the System are periodically put to work – and at an accelerating rate – in systemic wars to implement upgraded international orders. The moment the anarchistic System reached the critical connectivity threshold (the singularity in finite time) in 1939, it produced 'infinite' amounts of tensions (free energy) and consequently collapsed, producing a dual-phase transition.

In the table below, I show some of the main characteristics of both finite-time singularity dynamics. The characteristics of the second finite-time singularity dynamic are calculated with the help of a 'model' derived from the first finite-time singularity dynamic and are speculative.

Properties of the first and second finite-time singularity dynamics		
	First finite-time singularity dynamic	Second finite-time singularity dynamic
Period	1495-1945	1945-2187
Scope	Europe/Global	Global
Purpose	Accommodating population growth in Europe	Accommodating global population growth
Effect	Step-by-step integration of units/states in Europe (core), expansion outside Europe to non-core. Implementation of two dedicated, non-anarchistic hierarchies in the core of the System (Europe) and the first global order at a global scale through a dual-phase transition (the fourth systemic war, the Second World War, 1939-1945)	Step-by step integration of units/states in the System. Implementation of a global, non-anarchistic order on a global scale in the System via a phase transition; according to the model of the second finite-time singularity dynamic through the eighth systemic war (2185-2187)
Number of cycles	4	4
Critical connectivity threshold	1939	2185

Table 8 *In this table, I show the main properties of the first and second finite-time singularity dynamics. This study suggests that the second finite-time singularity dynamic is now in the high-connectivity regime of its first cycle. The properties of the second finite-time singularity dynamic are 'calculated' using the first finite-time singularity dynamic (1495-1945) and a theoretical (undistorted) version of the first finite-time singularity dynamic as references.*

Because the physical laws and mechanisms determine and shape the dynamics and development of the System to a high degree, it is possible to distinguish between a deterministic and contingent domain in the System. Both domains are linked through an 'interface', and the interface is responsible for the synchronization of the dynamics of both domains. The security dilemma and interacting self-fulfilling prophecies constitute the main mechanisms of the interface.

By virtue of the security dilemma and the interacting self-fulfilling prophesies between states in anarchistic systems, states and their populations collectively create their own realities to justify their decisions and (inter) actions; this mechanism is an intrinsic component of the finite-time singularity dynamic that developed and unfolded during the 1495-1945 period. The distinction between the two domains and an interface that links them overall serves analytical purposes.

It is possible to determine a counterpart in the contingent domain of the System for each deterministic dynamic and property of the System (see the table below).

Deterministic and contingent counterparts	
Deterministic properties, mechanisms, and dynamics	**Manifestation in the contingent domain**
Connectivity growth and free energy production.	Increased interdependence, accompanied by increasing tensions.
Application of the second law of thermodynamics to free energy produced in the System as a consequence of the intrinsic incompatibility between connectivity and security in anarchistic systems.	The 'emergence' of a finite-time singularity dynamic, accompanied by four accelerating cycles.
Consistent with the second law of thermodynamics free energy is put to work to implement upgraded orders that allow for a lower energy state of the System.	Implementation of international orders with increasingly comprehensive arrangements, through systemic wars.
Criticality, critical point.	Systemic war.
Intrinsic incompatibility between connectivity and security in anarchistic systems.	Intrinsic incompatibility between interdependence and security in anarchistic systems.
Path-dependence and lock-in towards increasing levels of order with increasing structural stability.	Path-dependence and lock-in towards successive international orders with increasingly comprehensive organizational arrangements; a process of integration
Competition between order (a lower energy state) and disorder (a higher energy state).	Competition between change and status quo. New order is implemented in the contingent domain by systemic wars. Systemic wars are ordering forces and cause change.
Realignment of nodes in the System during criticality to increase the System's structural stability and lower its energy state.	Implementation of changes in successive international orders during systemic wars, through 'privileges' that reflect the actual position of Great Powers in the (updated) status hierarchy of the System.
Increasing local stability of nodes of the System during high-connectivity regimes of relatively stable periods.	Decreasing size of non-systemic wars during high-connectivity regimes of successive relatively stable periods.
Increasing overall stability and optimization of the System, through crystallization in fractal structures, that minimizes free energy production (during relatively stable periods), and optimizes the deployment of destructive energy during critical periods (systemic wars).	A decrease in Great Power status dynamics, and a simultaneous decrease in changes in physical properties of the System (sizes of states). Eventually, the size distribution of states could be best described by a power law.
Coevolution of nodes (states) and of self-organized collective structures (international orders).	A 'powerful-become-more-powerful' dynamic; coevolution of certain properties of states and the international orders they design and implement.
A dual-phase transition when the critical connectivity threshold (the singularity in finite time) of the anarchistic System was reached in 1939.	The simultaneous implementation of two non-anarchistic hierarchies in the core of the System (Europe), and the first global order at a global scale, through the Second World War (1939-1945).
The second law of thermodynamics and related free energy principles.	The urge to survive of states and their populations.

Table 9 *This table shows a number of deterministic properties, mechanisms, and dynamics and their contingent counterparts.*

It is also possible to link changes in the deterministic domain to their contingent counterparts (see statement 20).

Related to the distinction between deterministic and contingent domains, I also introduce the term 'contingent latitude'. This study shows that the deterministic domain puts a decisive mark on the dynamics and development of the System; for example, the timing and duration of systemic wars and the destructive energy that is put to work during these wars are determined by the 'demands' of the second law of thermodynamics. Non-systemic war dynamics (non-systemic energy releases during relatively stable periods (international orders)) are also deterministic in nature. Thus, under 'normal' conditions (when the number of degrees of freedom (n) in the System is at least three), the System produces chaotic, non-systemic war dynamics. Under 'abnormal' conditions (when n = 2), the non-systemic war dynamics are either periodic (during the first exceptional period, 1657-1763) or highly subdued (during the second exceptional period, 1953-1989).

Given that the deterministic domain has such a decisive impact, less latitude remains for contingency and 'free will'. I refer to the latitude that remains in the System's dynamics as 'contingent' latitude'. Over time, during the unfolding of the first finite-time singularity dynamic that was accompanied by four accelerating cycles (1495-1945), the contingent latitude of the System decreased because of the path-dependent nature of the singularity dynamic and its lock-in on the accelerating implementation of upgraded orders by means of systemic wars to ensure compliance with the second law of thermodynamics.

The issues over which systemic wars were fought (and will be fought in the (near) future) and the 'cast' of these events is determined in the contingent domain of the System and is part of the System's contingent latitude. The deterministic domain allows this latitude as a means of expressing that it 'does not care' what occurs in the contingent domain, as long as its requirements are met.

Deterministic and contingent properties of systemic wars	
Deterministic properties	Contingent properties
Start time, duration, amount of free energy that has to be put to work to implement an upgraded order, direction of development towards increased order.	Why or what social issues the war is fought for, what events trigger the war, how the war is fought.

Table 10 *This table specifies deterministic and contingent properties of systemic wars.*

However, this study also shows that in some cases, events (interactions between states) in the contingent domain of the System influence the deterministic mechanisms that apply in the deterministic domain. For example, the number of degrees of freedom in the System determines the nature of non-systemic war dynamics during relatively stable periods (international orders). When this number is larger than two (n > 2), non-systemic war dynamics are chaotic in nature, but when n = 2, these dynamics are periodic or highly subdued.

The relationship between the number of degrees of freedom in a system and the nature of its dynamics is a deterministic 'law'. However, the number of degrees of freedom in the System itself is determined by the level of intensity of the rivalry between Great Powers in the anarchistic System, which is a matter of contingency, to a large extent.

In cases of intense rivalries, the number of degrees of freedom in the System is reduced to only two, as was the case during the first exceptional period (1657-1763) and the second exceptional period (1953-1989) as a consequence of the intense rivalries between Britain and France and between the United States and the Soviet Union, respectively. During the first exceptional period (1657-1763), the System produced periodic, non-systemic war dynamics, whereas during the second exceptional period (1953-1989), the non-systemic war dynamics were highly subdued.

The moment these rivalries were 'settled' (at least resolved to a degree), as was the case in 1763 (when the Seven Years' War (1755-1763) concluded in favor of Britain) and in 1989 (with the collapse of the Eastern hierarchy), the System was again 'governed' by three degrees of freedom (n > 2) and immediately resumed chaotic, non-systemic war dynamics, as the trajectories in the phase state of the non-systemic wars clearly demonstrate.

The 'abnormal' – non-chaotic – non-systemic war dynamics during the first exceptional period led to a delay in the development of the second cycle (1648-1815) of the first finite-time singularity dynamic and energy inefficiencies, as I explain in this study. The effects of the abnormal war dynamics during the second exceptional period cannot yet be accurately determined.

006 The second law of thermodynamics imposed an optimum order on the anarchistic System that allowed – and still allows – collective survival.

This study shows that the anarchistic System exhibits an inherent tendency to develop toward self-organized states of optimum order. As a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems, there is a continuous input of free energy (tensions) into the System; thus, the anarchistic System is a disequilibrium system.

The second law of thermodynamics applies to the free energy that is produced by the System. Consistent with the 'demands' of the second law of thermodynamics, free energy is (periodically) put to work through systemic wars to implement upgraded orders that foster lower energy states in the System. A lower energy state signifies relative stability and new opportunities for growth.

During the 1495-1945 period, the anarchistic System produced a finite-time singularity dynamic that was accompanied by four accelerating cycles; because the System produced free energy at an accelerating rate, upgraded orders had to be implemented at an accelerating pace to ensure consistency with the second law of thermodynamics.

Through a self-organized, finite-time singularity dynamic accompanied by four accelerating cycles, the anarchistic System ensured an optimal balance between order and disorder. This optimum order ensured an optimal balance between the performance of the System and its evolvability. Performance refers to the ability of the anarchistic System to fulfill the basic requirements of uneven and (increasingly) interdependent states in the anarchistic System, and evolvability refers to the System's ability to make timely adaptations to the increased connectivity of the System and the higher levels of free energy (tensions) these adaptations imply.

I argue that the optimum order of the anarchistic System during the 1495-1945 period ensured maximal population growth by ensuring – by striking – an optimal balance between order and disorder and between performance and evolvability. During the 1495-1945 period, the population in Europe (the core of the anarchist System) increased from approximately 83 million circa 1495 to 544 million in 1945.

By enabling maximal population growth, the finite-time singularity could ensure its development and unfolding: population growth drove connectivity growth, and connectivity growth ensured the production of sufficient free energy to 'power' the finite-time singularity dynamic. The finite-time singularity dynamic was accompanied by four accelerating cycles during the 1495-1945 period, and population growth constituted a self-reinforcing (positive feedback) mechanism.

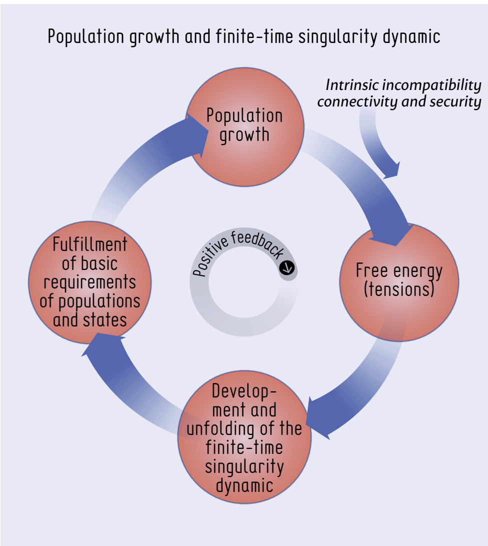


Figure 6
This causal loop diagram (CLD) shows the interaction between the finite-time singularity dynamic and population growth in the System. In an anarchistic system, population growth results in connectivity growth and the production of free energy (tensions). The free energy is then used to 'power' the further development and unfolding of the finite-time singularity dynamic. The finite-time singularity dynamic ensures that the basic requirements of populations (states) in an anarchistic system can be fulfilled. This is a positive feedback - self-reinforcing - mechanism. Because free energy is produced at an accelerating rate, the development and unfolding of the finite time singularity dynamic also accelerates.

The unfolding of a finite-time singularity dynamic with four accelerating cycles (during the 1495-1945 period) and the population growth it facilitated was accompanied by a number of simultaneous and related developments in the anarchistic System, including:

1 ***Consolidation and a SIE process at the unit level***
During the unfolding of the finite-time singularity dynamic, the core of the System (Europe) developed from a large collection of loosely connected and diverse units (1495) into a highly integrated system of 25-30 highly standardized states (1939).

2 ***Increasing and eventually complete structural stability***
During the unfolding of the finite-time singularity dynamic, the core of the System (Europe) reached complete structural stability: During successive cycles, Great Power status dynamics decreased linearly and eventually (during the fourth international order, 1918-1939) came to a complete stop (suggesting complete permanence of the Great Power status hierarchy); concurrently, the physical structures (the territories that states controlled) of the core of the System crystallized into fractal structures and became permanent as well; fractality indicates optimal distribution (of free energy and destructive power).

3 ***Integration of state structures into dedicated, non-anarchistic hierarchies***
Because of the accelerated production of free energy (tensions) in the anarchistic System, free energy had to be put to work to implement upgraded order at an accelerated pace; free energy was (and is) put to work by means of systemic wars. When the anarchistic System reached its critical connectivity threshold (the singularity in finite time) in 1939 and consequently produced 'infinite' amounts of free energy, it collapsed.

In response – to ensure consistency with the requirements of the second law of thermodynamics – the System produced a dual-phase transition. The dual-phase transition resulted in the simultaneous implementation of two dedicated, non-anarchistic hierarchies in the core of the System and the first global order on a global scale in the System. In the contingent domain of the System, the second law of thermodynamics imposed a process of integration – of SIE – on the anarchistic System and 'forced' states to cooperate to avoid the production of unsustainable levels of free energy that would put their collective survival at risk.

4 ***Simultaneous integration and expansion***
As the core of the anarchistic System (Europe) became increasingly integrated, the core of the System – states in the core of the System – also expanded to non-core territories. The expansion of core states to the non-core not only contributed to their power and influence (in the core) but also resulted in the implementation of state structures in the non-core part of the System. The non-core part of the System increasingly developed its own 'autonomous'

dynamics, which increasingly contributed to the total production of free energy in the System.

Eventually, the core and non-core parts of the System merged via the fourth systemic war (the Second World War, 1939-1945) – which constituted a dual-phase transition – and the distinction between core and non-core lost its original meaning.

007 It is possible to distinguish four types – levels – of closely related and interacting dynamics in the anarchistic System (1495-1945).

This study shows that it is possible to distinguish four 'types' of dynamics in the anarchistic System, and these dynamics are closely related.

The analyses show that the anarchistic System produced *one* finite-time singularity dynamic during the 1495-1945 period that was accompanied by *four* accelerating cycles, and each cycle consisted of a relatively stable period followed by a systemic war. During the same period, the System produced eighteen '*orbits*' (assuming that the non-systemic war dynamics during the 1657-1763 period would not have been temporarily distorted). In total, the System produced 97 *non-systemic wars* (expansion wars excluded); such non-systemic wars take place during relatively stable periods of cycles.

Orbits consist of a number of non-systemic wars that compose 'circular' trajectories in phase states (phase state is defined by size (fraction) and intensity) and are – I assume – produced by the chaotic, non-systemic war dynamics that typically have such 'strange' attractors.

The numbers 1, 4, 18, and 97, which represent the number of singularity dynamics, cycles, orbits, and non-systemic wars, respectively, qualify as a Zipfian distribution.

However, this is not the only remarkable regularity; both the number of non-systemic wars occurring during successive cycles and the number of orbits into which they can be grouped (assuming no distortion during the second cycle) decreased linearly.

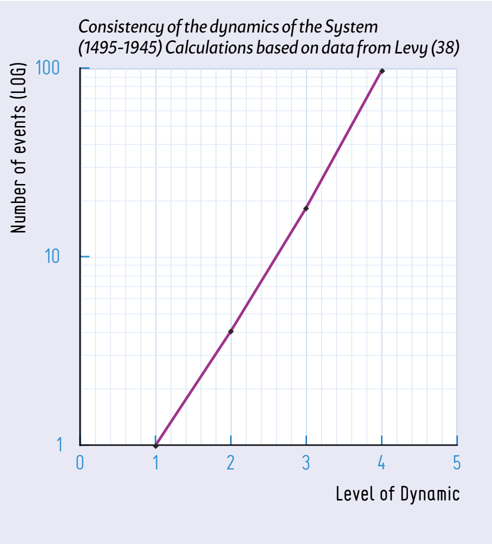
Consistency of dynamics of the System (1495-1945) Calculations based on data from Levy (38)			
Level	Dynamic	Number of occurrences	Remarks
1	Finite-time singularity	1	
2	Cycle	4	Accelerating
3	Orbit	18	Number determined through interpolation.
4	Non-systemic wars	97	During successive relatively stable periods (international orders) the System produced respectively: 45 - 34 - 16 - 2 non-systemic wars; expansion wars excluded.

Table 11 *This table shows the number of occurrences of four types of dynamics in the System during the 1495-1945 period.*

Occurrences of dynamics per cycle (1495-1945) Calculations based on data from Levy (38)					
Type	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Total
Non-systemic wars (level 4)	45	34	16	2	97
Orbits (level 3)	9	6 (Est. through interpolation)	3	0	18
Cycles (level 3)	1	1	1	1	4
Finite-time singularity dynamic (level 1)					1

Table 12 *Specification of dynamics of cycles of the first finite-time singularity dynamic (1495-1945).*

Figure 7
This figure shows the number of non-systemic wars (97, nine expansion wars excluded), orbits (18) and cycles (4), that constituted the first finite-time singularity (1495-1945). The number of occurrences of respective dynamics qualify as a Zipfian distribution.



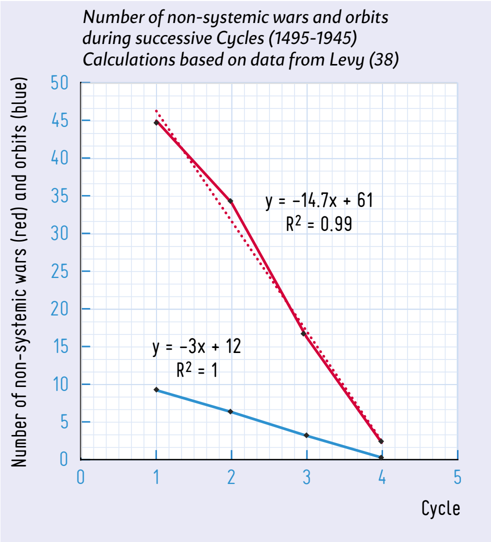


Figure 8
This figure shows the number of non-systemic wars (in red, expansion wars excluded, 45 - 34 - 16 - 2) and the number of orbits (in blue, 9 - 6 - 3 - 0, number of orbits of the second cycle based on interpolation) the anarchistic System produced during successive cycles of the first finite-time singularity dynamic (1495-1945). I argue that the System would have produced six orbits during the second cycle if the System's non-systemic war dynamics would not have been disturbed during the first exceptional period (1657-1763). The number of orbits of the first, third and fourth cycle (respectively: nine, three and zero) is based on empirical data. The number for the third cycle (six) is determined by interpolation.

Each dynamic – component of the anarchistic System – fulfilled a particular function.

Properties of the 'levels' of dynamics
Calculations based on data from Levy (38)

Level	Type/function	Nr.	Distribution during cycles	Remarks
1	*Non-systemic wars:* Release of local tensions; solution of local issues	97	Occurrences decrease linearly: 45-34-16-2	Nine expansion wars excluded. Normally chaotic in nature, except for the first exceptional period (1657-1763).
2	*Orbits:* Maintaining a functional balance during international orders	18	Occurrences decrease linearly: 9-6-3-0	Number of orbits during second cycle established through interpolation. Occurrences of orbits can be attributed to the shape of the chaotic attractor.
3	*Cycles/systemic wars:* Fulfillment of basic requirements; implementation of upgraded orders	4		Frequency and amplitudes grow at an accelerating rate.
4	*Finite-time singularity dynamic:* Balancing order/disorder; ensuring performance and evolvability; integration and expansion; enabling population growth	1		The anarchistic System reaches its critical connectivity threshold in 1939, resulting in collapse and a dual-phase transition. The structural stability, robustness and fragility of the System increase linearly and reach absolute levels shortly before the System's collapse in 1939.

Table 13 *This table shows the functions of the four 'types' of dynamics that can be distinguished during the unfolding of the first finite-time singularity dynamic.*

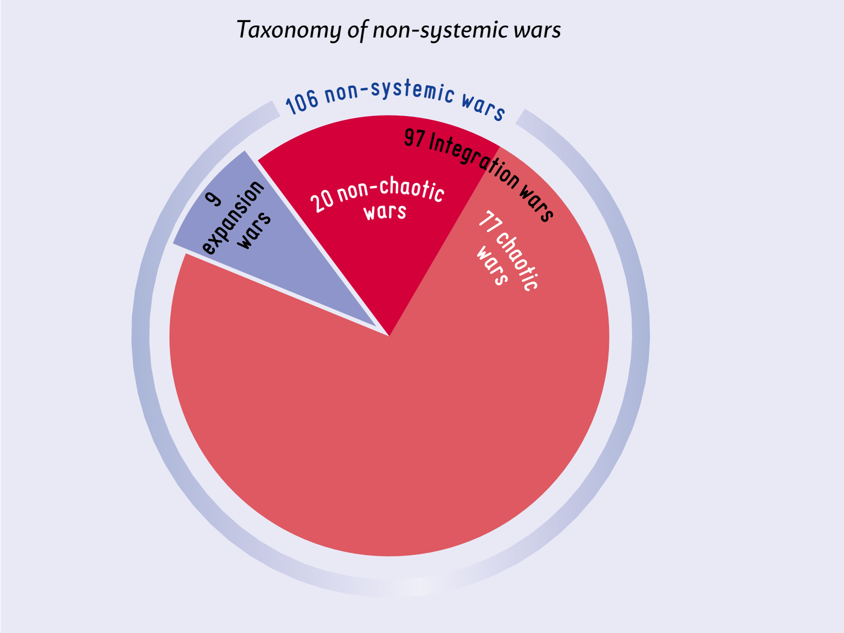


Figure 9 *This figure shows a taxonomy of the non-systemic wars during the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945).*

008 The cycles of finite-time singularities have identical life cycles.

The first finite-time singularity dynamic (1495-1945) was accompanied by four accelerating cycles; the System is presently in the first cycle of the second singularity dynamic (1945-...). Cycles – which are equivalent to oscillations – are a consequence of delayed responses by the System to distortions of its balance; the acceleration of successive cycles can be attributed to the increasing connectivity of the System, and connectivity determines the 'pace of life' in the System.

The cycles that accompany finite-time singularity dynamics typically consist of relatively long stable periods during which the System is in a subcritical condition followed by short critical periods. In the contingent domain of the System, relatively stable subcritical periods and critical periods manifest themselves as 'international orders' and systemic wars, respectively. During relatively stable periods (international orders), the anarchistic System produces non-systemic energy releases – non-systemic wars – to regulate both its balance and energy state.

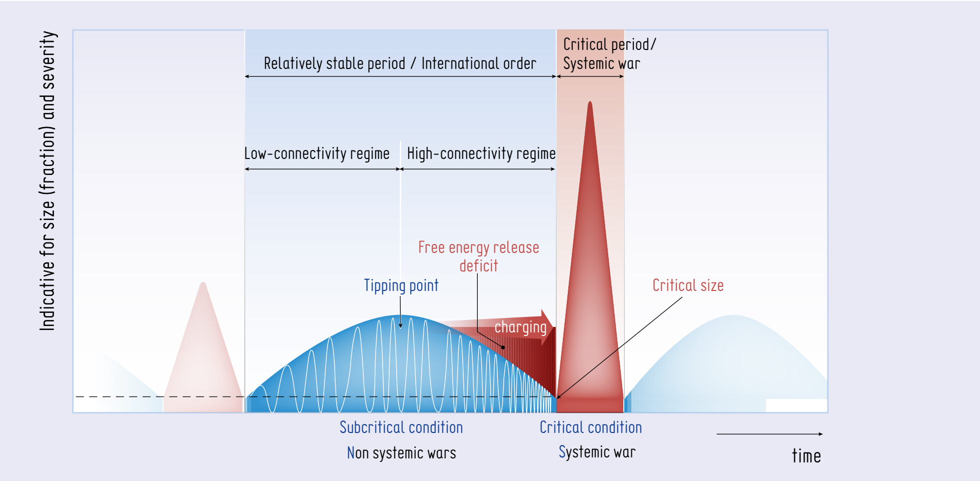


Figure 10 *This figure shows a schematic representation of a typical cycle. The finite-time singularity dynamic that developed and unfolded in the System during the period 1495-1945, was accompanied by four accelerating cycles. Cycles have similar life cycles. This study suggests that the System is presently in the high-connectivity regime of the first cycle of the second finite-time singularity dynamic (1945-...), and is 'charging', and storing free energy (unresolved issues and tensions) that crystalize in vulnerable issue clusters. The moment the clusters percolate the System, the System will become critical and produce a systemic war.*

This study shows that during international orders (relatively stable periods), non-systemic war dynamics are normally chaotic in nature. However, there are two exceptions: (1) periodic hyper-excited war dynamics during the first exceptional period (1657-1763) during the second cycle (1648-1815) of the first finite-time singularity dynamic (1495-1945), and (2) subdued, non-chaotic, non-systemic war dynamics during the second exceptional period (1953-1989) during the first cycle (1945-...) of the second singularity dynamic (1945-...).

The nature of non-systemic war dynamics – chaotic or non-chaotic (i.e., periodic or subdued, respectively) – is determined by the number of degrees of freedom in the System; thus, the intensity of the rivalry between Great Powers determines the number of degrees of freedom in the System. During the first exceptional period (1657-1763) and second exceptional period (1953-1989), the number of degrees of freedom in the System were temporarily reduced as a consequence of the intense rivalries between Britain and France and between the United States and the Soviet Union, respectively.

Typically, during relatively stable periods, two 'regimes' can be established. These regimes, consisting of a low-connectivity and a high-connectivity regime, are divided by a tipping point. During low-connectivity regimes, the connectivity of the issue network remains limited, and an increase in its connectivity results in larger, non-systemic wars. However, once the tipping point of the international order is reached and the System is in a high-connectivity regime, increasing the connectivity of the issue-network makes states more stable; the so-called connectivity/local stability effect results in a decrease in the size of non-systemic wars.

This effect has a fundamental impact on the System's dynamics and development: during high-connectivity regimes in relatively stable periods (international orders), free energy (tensions) is (increasingly) 'stored' in the System instead of being released. The stored tensions (which include unresolved issues) form a 'free energy release deficit' and crystallize in vulnerable issue clusters with fractal structures.

The moment these vulnerable issue clusters percolate through the System, the System becomes critical and highly sensitive to perturbations and produces a systemic war.

During these systemic wars, states 'use' the properties of critical systems (i.e., under those conditions, system-wide communication, coordination and planning is 'enabled') to collectively design and implement upgraded orders.

Consistent with the demands of the second law of thermodynamics, upgraded orders enable lower energy states in the anarchistic System – for 'new', relatively stable periods – that give states and their populations the opportunity for further growth.

The high-connectivity regimes of relatively stable periods (international orders) are instrumental in 'charging' the anarchistic System's systemic wars.

Fundamental differences between relatively stable and critical periods of cycles		
	Relatively stable period	Critical period
Manifestation in the contingent domain of the System	International order	Systemic war
Condition	Subcritical	Critical
Function	Enabling the balanced fulfillment of the basic requirements of states and their populations and their further growth; relatively stable periods/international orders determine the performance of the System	Adapt to changed circumstances by implementing an upgraded order, consistent with the second law of thermodynamics; critical periods/systemic wars determine the evolvability of the System
Duration	Relatively long	Relatively short
Type of energy releases	Non-systemic	Systemic
Impact of energy releases (wars) on the long-term development of the System	No significant impact	Significant impact; critical periods (systemic wars) define the System
Nature of dynamics	Normally chaotic; non-chaotic during exceptional periods (hyper-excited or subdued)	Chaotic
Driver of pace of life	Connectivity; relatively stable periods and critical periods accelerate at similar rates	Connectivity; relatively stable periods and critical periods accelerate at similar rates

Table 14 *This table provides an overview of the fundamental differences between the relatively stable and the critical periods of cycles.*

009 During relatively stable periods (international orders), low- and high-connectivity regimes that are divided by a tipping point can be distinguished; these regimes determine and shape the sizes and frequencies of non-systemic wars during relatively stable periods.

During relatively stable periods (international orders), the sizes and frequencies of non-systemic wars follow a typical pattern: initially, following a systemic war, the sizes of non-systemic wars increase on average; at a certain moment, they reach a tipping point and then begin to decrease in size. Shortly before a systemic war 'emerges', the size of non-systemic wars is small, and the System is remarkably stable.

Tipping Points of international orders during relatively stable periods (1495-1945)

International order	Period	Tipping Point
1	1495 - 1618	1514
2	1648 - 1792	1774
3	1815 - 1914	1856
4	1918 - 1939	Not applicable

Table 15 *This table shows the tipping points of the first three relatively stable periods (international orders) of the first finite-time singularity dynamic (1495-1945).*

I propose that during low-connectivity regimes, the increasing connectivity of the issue network (of which states are integral parts) results in non-systemic wars of increasing size (where size is defined in terms of fraction). However, once the tipping point of the relatively stable period is reached, the System is in a high-connectivity regime; during high-connectivity regimes, the connectivity/local stability effect leads to a decrease in the size of non-systemic wars.

From this perspective, it is possible to make a distinction between non-systemic wars that occurred during low- and high-connectivity regimes.

Based on this perspective, six war clusters can be identified during the first three relatively stable periods (1495-1616, 1648-1792, and 1815-1914). Because of the low number (two, excluding expansion wars) of non-systemic wars during the fourth relatively stable period (1918-1939), war clusters cannot be identified during this period.

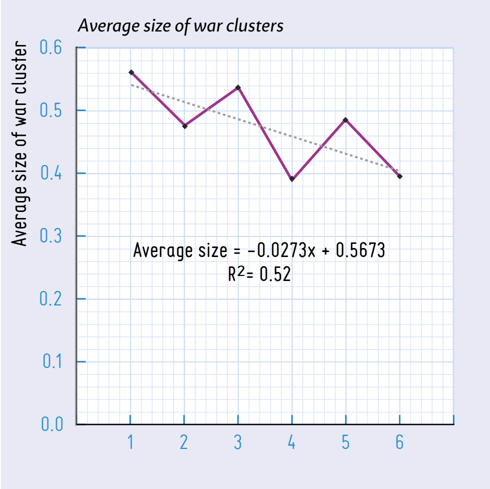
Identification and properties of war clusters Data from Levy (38)								
	Low-connectivity war clusters				High-connectivity war clusters			
Int. order	Cluster	Nr. of wars	Average size	Frequency	Cluster	Nr. of wars	Average size	Frequency
1	1	2	0.560	0.250	2	25	0.473	0.223
2	3	19	0.534	0.151	4	3	0.389	0.176
3	5	4	0.483	0.098	6	4	0.392	0.070

Table 16 *This table shows six war clusters and some of their properties that can be distinguished during the first three relatively stable periods (international orders), including the number of non-systemic wars each cluster produced between Great Powers, and their average size and frequency. Size is defined in terms of the fraction of Great Powers participating in a war divided by the total number of Great Powers in the System at that moment in time; it is a relative measure.*

When the average sizes and the frequencies of wars constituting the respective war clusters are calculated, these calculations reveal a number of similarities.

1 ***Size development***
In all cases, the average size of wars comprising low-connectivity war clusters is larger than the average size of wars comprising high-connectivity regimes (in the same relatively stable period). Overall, a downward trend can be observed.

Figure 11
This figure shows the average size (defined as fraction) of six war clusters that can be distinguished during the first three relatively stable periods (international orders). Orders 1-2, 3-4, and 5-6 respectively concern the first (1495-1618), second (1648-1792) and third (1815-1914) relatively stable periods (international orders). War clusters 1, 3, and 5 are low-connectivity clusters; 2, 4, and 6 represent high-connectivity clusters. Data from Levy (38).



2 ***Frequencies***
The reverse is the case for the frequencies of wars comprising war clusters: the frequency of low-connectivity regimes is consistently lower than that of high-connectivity regimes. However, a significant distortion can also (but not surprisingly) be observed: the frequencies of the third and fourth war

clusters – the war clusters during the second relatively stable period (1657-1763) of the second cycle – are 'extreme' and do not follow the ('underlying') trend.

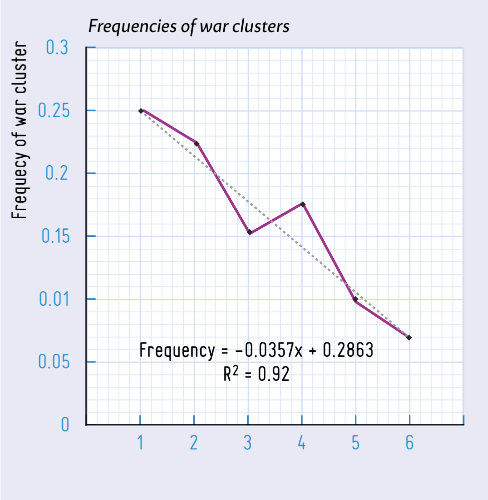


Figure 12
This figure shows the frequencies of non-systemic wars (number of wars divided by the life span of the cluster) during six war clusters that can be distinguished during the first three relatively stable periods (international orders). Orders 1-2, 3-4, and 5-6 respectively concern the first (1495-1618), second (1648-1792) and third (1815-1914) relatively stable periods (international orders). War clusters 1, 3, and 5 are low-connectivity clusters; 2, 4, and 6 represent high-connectivity clusters. Data from Levy (38).

However, it also seems that fluctuations in the average sizes and frequencies of war clusters canceled one another out. To show this effect, I calculated the product of the average sizes and frequencies of respective war clusters; I refer to this property as the volatility index of the System (VIXS). During the first three cycles, the VIXS decreased approximately linearly.

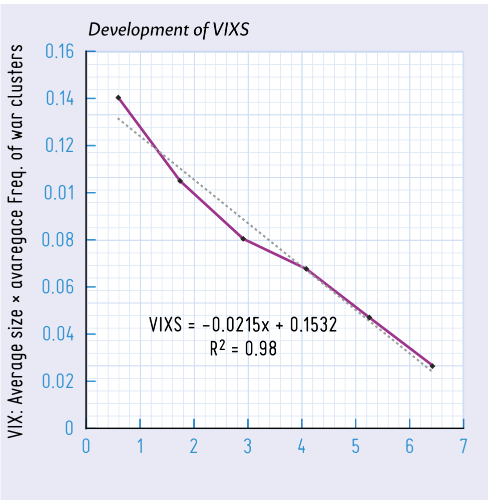


Figure 13
This figure shows the development of the volatility index of the System (VIXS) during the first three relatively stable periods (international orders): The VIXS decreased about linearly, suggesting that distortions in the average size and frequencies of war clusters were 'leveled out' (corrected). Orders 1-2, 3-4, and 5-6 respectively concern the first (1495-1618), second (1648-1792) and third (1815-1914) relatively stable periods (international orders). War clusters 1, 3, and 5 are low-connectivity clusters; 2, 4, and 6 represent high-connectivity clusters. Data from Levy (38).

010 During the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the structural stability, robustness and fragility of the anarchistic System (successive cycles) developed consistently and very regularly.

During the unfolding of the first finite-time singularity dynamic (1495-1945) accompanied by four accelerating cycles, a number of the properties of the anarchistic System developed very regularly and consistently. These properties are a function of the System's connectivity. The regularities in these properties can be identified when the four accelerating cycles that accompanied the finite-time singularity dynamic are used as units of analysis.

1 ***Structural stability***

The structural stability of the successive cycles of the anarchistic System is related to the permanence of the System's structure(s). I distinguish between the organizational and physical structures of the System; thus, these structures – and their permanence – are related.

Great Power status dynamics (i.e., the permanence of the Great Power status hierarchy of the System) are a measure of the permanence of the System's organizational structure. During the unfolding of the singularity dynamic, the Great Power status dynamics decreased linearly and came to a halt during the fourth international order (1918-1939) shortly before the System's collapse.

During the unfolding of the first finite-time singularity dynamic, which was accompanied by four accelerating cycles, the core of the System (Europe) developed from a large collection of loosely connected and diverse units (1495) into a highly integrated anarchistic System consisting of 25-30 highly standardized states (1939). As units and states 'consolidated', states simultaneously crystalized into fractal structures. Ultimately, during the fourth international order (1918-1939), the size distribution of the states in the System could be best described by a power law and had become permanent.

Indicators and measures of structural stability of the anarchistic System

Order	Indicator	Measure	Mechanism
Organizational	Permanence of the Great Power status hierarchy	Great Power status dynamics	Coevolution of states and successive international orders, path dependence and lock-in, the 'powerful-become-more-powerful- effect'
Physical	Permanence and size distribution of states	Border changes, and power-law fit	The second law of thermodynamics

Table 17 *This table defines indicators and measures of structural stability of the anarchistic*

2 ***Robustness***

I define the robustness of the anarchistic System as its ability to 'absorb' perturbations during relatively stable periods (international orders) without producing non-systemic energy releases (non-systemic wars). I consider the number of non-systemic wars during relatively stable periods and war frequency during relatively stable periods as measures of the robustness of the cycles (the System). During the unfolding of the first singularity dynamic, the number of non-systemic wars and non-systemic war frequency decreased linearly. During the fourth international order, the robustness of the anarchistic System became absolute ('infinite').

3 *Fragility*

The fragility of the anarchistic System relates to its ability to maintain itself within international orders (which regulate the System during the relatively stable periods of cycles). The lifespans of international orders (relatively stable periods) are a measure of its fragility. The lifespan of successive international orders became shorter at an accelerating rate.

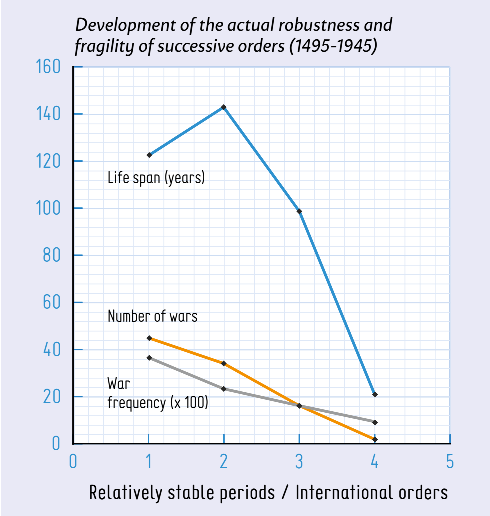
The robustness and fragility of the System are related properties that are two sides of the same coin. Increasing robustness and increasing fragility go hand-in-hand; the robustness and fragility of the System became absolute (infinite) concurrently, shortly before the System's collapse in 1939. The moment the System reached absolute robustness, it could no longer release free energy (tensions) via non-systemic energy releases (non-systemic wars), while the anarchistic System simultaneously produced infinite amounts of free energy (tensions). The only option remaining was to release energy through a systemic war.

Development of the actual robustness and fragility of successive international orders (1495-1945)

Rel. Stable period / int. Order	Period	Life span	Number of non-systemic wars	War Frequency
1	1495-1618	123	45	0.37
2	1648-1792	144	34	0.24
3	1815-1914	99	16	0.16
4	1918-1939	21	2	0.10

Table 18 *This table shows the indicators for the actual robustness (number of non-systemic wars and war frequency of international orders, eight expansions wars excluded) and for the fragility of successive orders (life span) of the first finite time singularity dynamic accompanied by four accelerating cycles (1495-1945).*

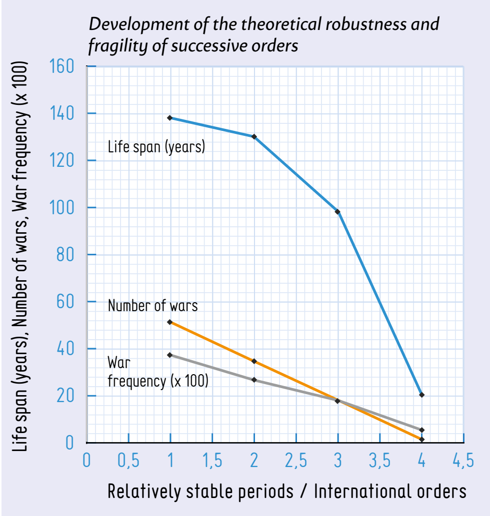
Figure 14
In this figure the development of the life spans of successive orders (blue) is shown (this is a measure for the fragility of the System), and of the absolute number of non-systemic wars (orange, eight expansion wars excluded) and of the war-frequency (x 100, grey) of successive international orders, which are measures for the robustness of the System. This figure concerns the actual finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945).



Development of the theoretical robustness and fragility of successive international orders				
Rel. Stable period / int. Order	Period	Life span	Number of non-systemic wars	War Frequency
1	NA	138	51	0.37
2	NA	130	34	0.26
3	NA	98	17	0.17
4	NA	20	1	0.05

Table 19 *This table shows the indicators for the theoretical robustness (number of non-systemic wars and war frequency of international orders; eight expansion wars excluded) and for the fragility of successive orders (life span) of the first finite time singularity dynamic accompanied by four accelerating cycles. NA means 'not applicable'.*

Figure 15
In this figure the development of the life spans of successive orders (blue) is shown; this is a measure for the fragility of the System, and of the absolute number of non-systemic wars (orange, eight expansion wars excluded) and of the war-frequency (x 100, grey) of successive international orders; measures for the robustness of the System. This figure concerns the theoretical finite-time singularity dynamic accompanied by four accelerating cycles.



The development of the structural stability, robustness and fragility of the System during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles points to the unavoidable collapse (in 1939) of the System following the fourth international order (1918-1939).

The fact that the System now – during the first international order (1945-…) of the second singularity dynamic (1945-…) – produces non-systemic wars indicates that the System is not (yet) absolutely robust and that the next systemic war will not constitute a phase transition.

011 In 1939, the System simultaneously reached the critical connectivity threshold and its 'anarchistic end state'. Concurrent with the anarchistic System's production of infinite amounts of free energy (tensions), this energy could no longer be put to work to (further) upgrade the order and performance of the anarchistic System. Consequently, the anarchistic System collapsed and produced a dual-phase transition to ensure compliance with the physical laws that apply to the System.

The robustness, fragility and structural stability of the anarchistic System increased consistently during the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945). These properties became 'absolute' during the lifespan of the fourth international order (the fourth relatively stable period, 1918-1939). At that point, the robustness and structural stability of the anarchistic System (its organization and physical structures) could not be further 'improved'. I refer to this fully developed condition of the anarchistic System as its 'anarchistic end state'.

In 1939, as the System reached the anarchistic end state during which free energy could no longer be put to work 'on behalf of' the anarchistic System, the same anarchistic System simultaneously reached its critical connectivity threshold and produced infinite amounts of free energy (tensions). Consequently, the anarchistic System collapsed and produced a phase transition to implement a fundamentally different order that would ensure (at least temporary) compliance with the second law of thermodynamics.

012 During the first relatively stable period (1495-1618, the first international order), the war dynamics of the anarchistic System constitute a damped oscillator.

It is possible to distinguish four components – four types of dynamics – in the anarchistic System during the 1495-1945 period: a single, finite-time singularity dynamic that was accompanied by four accelerating cycles and consisted of 16 orbits (if the war dynamics were not distorted during the 1657-1763 period) and 97 non-systemic wars (expansion wars excluded).

The 16 orbits produced by the anarchistic System that can be identified in phase state (defined by the size (fraction) and intensity of the non-systemic wars) are a 'product' of the chaotic nature of the non-systemic war dynamics in the System. Each orbit consists of a number of non-systemic wars.

Within the lifespan of the first international order, nine of these orbits can be identified.

Wars constituting nine orbits during the first international order (1495-1618) ***Data based on Levy (38)***						
Nr. Levy	War/orbit	Direction	Intensity	Fraction	Start	End
1	1/1	R	119	0.60	1495	1497
2	2/1	R	45	0.20	1497	1498
3	3/1	R	60	0.20	1499	1503
4	4/1	R	29	0.20	1499	1500
5	5/1	R	269	0.40	1501	1504
6	6/1	R	145	0.60	1508	1509
7	1/2	L	261	0.80	1511	1514
8	2/2	L	343	0.40	1512	1519
9	3/2	L	57	0.20	1513	1515
10	4/2	L	43	0.60	1515	1515
11	5/2	L	420	0.75	1521	1526
12	1/3	L	958	0.50	1521	1531
13	2/3	L	41	0.25	1522	1523
14	3/3	L	249	0.75	1526	1529
15	4/3	L	384	0.50	1532	1535
16	1/4	L	55	0.25	1532	1534
17	2/4	L	438	0.50	1536	1538
18	3/4	L	1329	0.50	1537	1547
19	4/4	L	176	0.25	1542	1550
20	1/5	?	629	0.50	1542	1544
21	2/5	?	107	0.50	1544	1546
22	3/5	?	79	0.50	1549	1550
23	4/5	?	578	0.50	1551	1556
24	5/5	?	668	0.50	1552	1556
25	1/6	R	676	0.40	1556	1562
26	2/6	R	316	0.60	1556	1559
27	3/6	R	78	0.40	1559	1560
28	4/6	R	310	0.40	1559	1564
29	5/6	R	77	0.40	1562	1564
30	6/6	R	306	0.40	1565	1568
31	7/6	R	608	0.40	1569	1580
32	1/7	R	600	0.40	1576	1583

Wars constituting nine orbits during the first international order (1495-1618) Data based on Levy (38)						
33	2/7	R	50	0.20	1579	1581
34	3/7	R	210	0.20	1583	1590
35	4/7	R	588	0.40	1585	1604
36	1/8	L	49	0.20	1587	1588
37	2/8	L	195	0.40	1589	1598
38	3/8	L	1086	0.40	1593	1606
39	4/8	L	24	0.20	1600	1601
40	1/9	R	175	0.33	1610	1614
41	2/9	R	70	0.17	1615	1618
42	3/9	R	23	0.17	1615	1617
43	4/9	R	58	0.14	1617	1621
44	5/9	R	69	0.29	1618	1619
45	6/9	R	173	0.14	1618	1621

Table 20 *The non-systemic wars the System produced during the first international order (1495-1618) of the first finite-time singularity dynamic (1495-1945), constitute nine orbits. Only one Great Power participated in wars marked with blue.*

Further analysis shows that these orbits – the non-systemic wars that constitute the respective orbits – did not develop randomly; on the contrary, they developed very consistently.

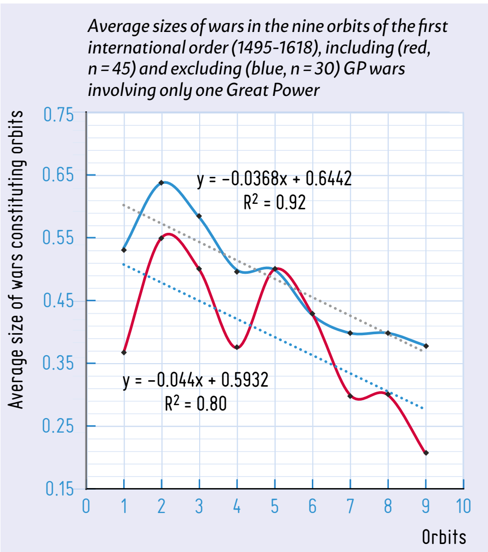


Figure 16
This figure shows the properties of the nine orbits the anarchistic System produced during the first relatively stable period (the first international order, 1495-1618). The properties developed very regularly: The orbits – the war dynamics during the first international order – constitute a damped oscillator. In the red plot Great Power wars with one Great Power are included (n = 45); in blue Great Power wars only involving one Great Power are excluded (n = 30).

The typical behavior of the non-systemic war dynamics during the first international order qualifies as a damped oscillator; by means of ‘clusters of wars' – grouped in orbits – the System continuously tried to (re-)establish a certain order to ensure that states (units) in the System could fulfill their basic requirements in the anarchistic System. In at least some respects, the damped oscillator during the first relatively stable period (1495-1618) fulfilled the same function for the international order that the finite-time singularity dynamic accompanied by four accelerating cycles fulfilled for the anarchistic System during the 1495-1945 period: maintaining a functional balance.

013 Three networks can be distinguished in anarchistic systems, and connectivity is the driver – the control parameter – of the System.

In the context of this study, a distinction can be drawn between three networks: an 'overall' network, issue networks, and vulnerable issue networks.

In all these cases, connectivity is the driver – the control parameter. However, its effects 'differ' depending on the network in question.

A distinction between the three networks in the System

	Overall network	Issue network	Vulnerable issue network
Definition, specification	This network (system) involves humans (individuals) and the numerous 'social systems' (groups, organizations, etc.) in which they group/cluster, including states. These groups and these humans must fulfill basic requirements to ensure their survival and the survival of their constituents. The network (the System) has a hierarchical (nested) structure. The interactions between the (numerous) components of this network are regulated by (different) rule sets.	Because of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems (see: 'Overall network'), the system produces free energy. Issues and tensions in the System are crystallizations of free energy in the contingent domain of the System. Issues are defined by (interactions between) states. Issues and states form an issue network.	Issues, of which states are integral parts, form issue networks. Vulnerable issue networks (clusters) are subsystems of the issue network. States in the issue network have a certain preparedness to engage in war because of these issues. Vulnerable issue networks connect issues and states; in these networks, states are 'one step' from switching to positive war decisions. Vulnerable issue clusters are one step (for example, one incident) from being 'activated'.
Connections and connectivity	In this study, I focus on the interactions and relationships between units and states, in particular.	Issues and states constitute the nodes of the issue network. Their interactions form the connections. During relatively stable periods, the connectivity of the issue network increases as a consequence of the continuous production of free energy. During the lifespan of relatively stable periods, low- and high-connectivity regimes and (the properties of) their related dynamics can be distinguished from one another.	The war decisions of states in the System qualify as binary decisions with externalities and thresholds. The war decisions of other states ('war' or 'no war') and the thresholds they (themselves) apply to war decisions determine their response to issues.

A distinction between the three networks in the System			
Driver of connectivity growth	Population growth is the main – 'underlying' – driver of this network. People and populations must fulfill basic requirements to survive; states are instrumental in fulfilling basic requirements. In fulfilling basic requirements, states and populations have become increasingly interdependent. However, connectivity growth – population growth – and security in anarchistic systems are intrinsically incompatible, and this incompatibility results in the production of free energy (tensions between states) in the System.	Free energy (tension) production in the System drives the connectivity of the issue networks.	The war decisions of other states connected to issue networks drive war decisions in the System. The properties of a vulnerable issue cluster (its connectivity, the thresholds of states) determine the war dynamics that the System produces.
Effects and impacts	The second law of thermodynamics (and a number of other laws and deterministic mechanisms) apply to the free energy (tensions) produced in the anarchistic System. Furthermore, I argue that the connectivity of the overall network determines the pace of life in the System. The acceleration of the finite-time singularity dynamic can be attributed to the increasing connectivity of the System, the amount of free energy that is produced, and the need (as determined by the second law of thermodynamics to put this energy to work at an accelerating pace.	The level of connectivity of the issue networks determines whether the relatively stable period is in a low- or high-connectivity regime. This regime determines, for example, the sizes of non-systemic wars and the ability of the System to store free energy, which then crystalizes in vulnerable issue clusters.	The level of connectivity determines the size and frequency of non-systemic wars.

Table 21 *This table provides an overview of the main characteristics of the three 'networks' that can be distinguished in anarchistic Systems. Connectivity is the driver of these networks.*

These networks have a nested structure, and they overlap to a degree: vulnerable issue networks/clusters form a sub-set of issue networks; issue networks can be considered a subset of an overall network. The fact that these networks form 'nested' sub-sets indicates that the driver of the overall network (population growth) indirectly impacts the driver of the issue network through the free energy population growth it (indirectly) produces.

In this study, I refer primarily to the 'connectivity growth of the System' without explicitly specifying sub-networks and sub-drivers.
In the table below, I provide an overview of various connectivity effects.

Direct and indirect connectivity effects	
Effect	Explanation
Increasing incompatibility of the System.	Connectivity and security are intrinsically incompatible in anarchistic systems. Incompatibility produces the tensions and free energy that power the singularity dynamic.
Emergence of a tipping point in the non-systemic war dynamics during relatively stable periods of cycles, marking a switch from a low- to high-connectivity regime.	During relatively stable periods the connectivity of the System increases. The connectivity of the System determines the size and frequency of non-systemic wars the System produces. When the System reaches the tipping point of relatively stable periods states become more stable because of (what I name) the connectivity/stability-effect; from that point onwards, until the System becomes critical, the size of non-systemic wars the System can produce decreases. This effect primes the System for systemic war.
Increasing pace of life.	Population size determines the pace of life of the System. An increase in the pace of life also implies in increase in the speed of spreading phenomena, including the spreading speed of tensions and hostilities in the System.
Increasing robustness and fragility.	Increasing connectivity of the System implies increased robustness and increased ability to absorb perturbations without producing non-systemic wars. Increasing robustness implies that the System's ability to produce free energy-release events (non-systemic wars) becomes increasingly limited/restrained. At the same time as the System's robustness increases, the fragility of the System (the ability of the System to maintain itself in a stability domain) decreases; robustness and fragility of the System are two sides of the same coin.
Increasing structural stability.	Connectivity increase also contributes to the structural stability of the System; its organizational stability (permanence) as well as the permanence (stability) of state-structures (form and size) in the System.
Increasing energy requirements of systemic wars to accomplish a rebalancing of the System through the implementation of upgraded orders.	Increased connectivity of the System impacts the energy required to rebalance the increasingly stable System.
Increasing interdependence.	Connectivity growth and growth of interdependence go hand-in-hand. Increasing interdependence has positive and negative effects in an anarchistic System. Positive: it improves the ability of states to fulfill certain basic requirements. Negative: it unavoidably produces issues and tensions that negatively affect the security of states, but also identities of humans and social systems.
Increasing alliance dynamics.	Increasing connectivity results in (more) issues and tensions in the System; in response states try to hedge certain risks by forming alliances.

Table 22 *This table shows and explains the most obvious connectivity effects.*

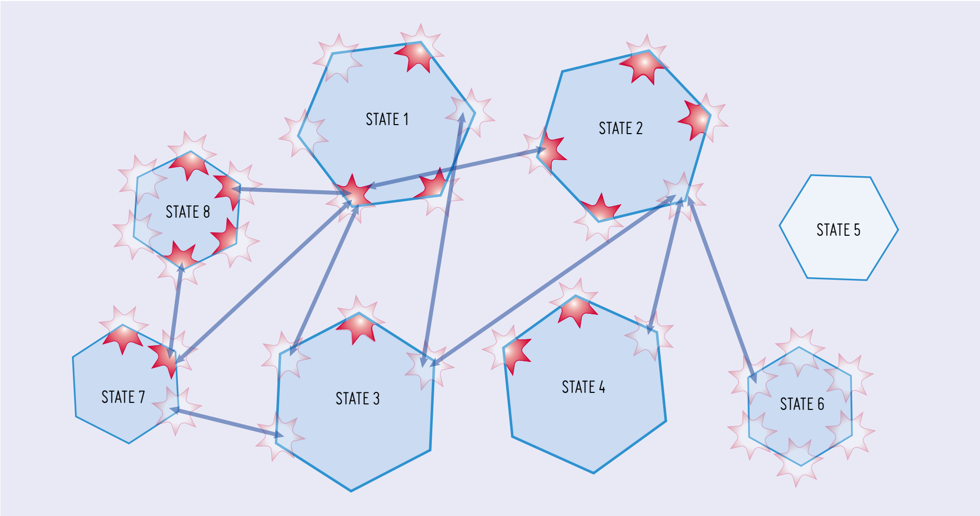


Figure 17 *This figure depicts the System as a network of binary 'war switches'. States constitute the switches (nodes) in this network. States are integral components of the network of vulnerable issue clusters. Vulnerable issue clusters are one step from being activated and producing a war (energy release). I assume that states are linked to (are integral parts of) a number of issues (and issue clusters) that during relatively stable periods develop in the System. The connectivity of the issue network determines if the System is in a low- or high-connectivity regime.*
In above figure, states are depicted as (blue) hexagons. Issues states have, are shown as ('thorny') stars. Issues of states can either be 'vulnerable' (depicted in dark red, one step from being activated in war) or 'not vulnerable'. Connectivity of states (to the issue network) and thresholds states use to decide to go to war (or not), determine the dynamics of the issue network and of the properties (size and frequency) of war dynamics in the System. In the present international order, the 'South China Sea' and the 'Ukraine' can be considered issue clusters.

014 (Systemic) wars are delayed responses to imbalances between order and disorder in the System, resulting in oscillations.

During the 1495-1945 period, the anarchistic System upgraded its order at an accelerating rate by means of systemic wars. Systemic wars were produced by a finite-time singularity that was accompanied by four accelerating cycles; each cycle consisted of a relatively stable period followed by a systemic war.

The accelerating finite-time singularity dynamic can be considered a 'product' of the free energy the anarchistic System produced at an accelerating rate and to which the second law of thermodynamics applies. The second law of thermodynamics 'demands' that free energy be put to work to implement upgraded orders that lead to lower energy states in the System; a lower energy state leads to a period of relative stability and the further (population) growth of states in the anarchistic System.

Free energy was (and still is) produced because of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems, and population growth is the driver of connectivity growth.

Population growth in (states of) the System and the finite-time singularity dynamic accompanied by four accelerating cycles together form a self-reinforcing (positive feedback) mechanism: Population growth powers the finite-time singularity dynamic, and the finite-time singularity dynamic guarantees maximal population growth by balancing order and disorder in the anarchistic System and ensuring the anarchistic System's performance and evolvability.

The finite-time singularity dynamic was accompanied by four accelerating cycles; during the relatively stable periods (international orders) of cycles, the System produced non-systemic wars. Typically, relatively stable periods were (and still are) followed by systemic wars. I assume that the severity of the wars is a measure of the destructive energy that was deployed during these wars; the 'amount' of destructive energy is a measure of the free energy that was produced by the anarchistic System.

In the table below, I show the 'total' severities of the successive cycles for both the actual and theoretical models of the first finite-time singularity dynamic.

I have constructed the theoretical model of the first finite-time singularity dynamic by fine-tuning the parameters and certain properties of the actual singularity dynamic, assuming maximal consistency of the singularity dynamic's properties and dynamics.

I have related the total severities of the successive cycles to the size of the European population at the beginning of the successive systemic wars.

Total severity (BCD) of cycles as proportions of the population size of the core of the System (Europe)				
Cycle	Year	Population size (in millions)	Actual FTS (BCD/pop size in %)	Theoretical FTS (BCD/pop size in %)
1	1618	115	2.59	2.64
2	1792	195	3.87	2.95
3	1914	450	1.87	1.94
4	1939	525	2.47	2.19

Table 23 *In this table, the population size (Europe) in the first year of systemic wars is related to the total severity of the respective cycles. These calculations suggest that the total severity of successive cycles as a proportion of population size behave as an oscillatory dynamic.*

On average, 2.7% of the population (of Europe) were casualties of the four systemic wars produced by the anarchistic System; however, this number reflects only the battle casualty deaths (BCD) of military personnel and not civilian casualties. In the case of the theoretical model, this percentage is 2.42, suggesting a 'small' (an understatement when the human suffering is taken into consideration) difference between the actual finite-time singularity dynamic and the theoretical model.

If these values are plotted in a diagram, an interesting pattern can be observed; see the figure below.

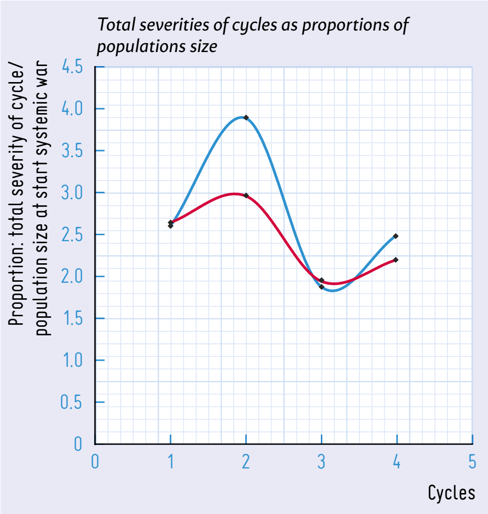


Figure 18
This figure shows the oscillating behavior of the four cycles that accompanied the first finite-time singularity dynamic (1495-1945); the actual oscillations and the oscillations of the theoretical model of the first finite-time singularity dynamic are depicted in blue and red, respectively (data used from Levy (38). The differences between the amplitudes of the second and fourth cycles can be attributed to the effects of the abnormal war dynamics during the first exceptional period (1657-1763) during the second cycle (1648-1815) and to the globalization effect during the fourth systemic war (1939-1945), respectively.

This figure shows that the total severities of the successive cycles as a fraction of the population size of the core of the System (Europe) constitute two oscillations that follow a slightly downward trend. The precision of the theoretical model is notable: the theoretical model has a 100% fit.

The oscillations suggest that the (systemic) wars were delayed responses (corrections) to imbalances in the anarchistic System that caused two 'overshoots' and one 'undershoot'. These delays were caused – enabled – by the metastable condition of the System during relatively stable periods; the international orders were instrumental in this metastability.

When the theoretical model is used as a reference, this figure makes it possible to identify two distortions in the actual finite-time singularity dynamic.

The two distortions are not surprisingly caused by the behavior of the second cycle (3.87% actual versus 2.95% theoretical) and the fourth cycle (2.47% actual versus 2.19% theoretical) as a consequence of the abnormal non-systemic war dynamics during the first exceptional period (1657-1763) and the globalization of the System during the fourth systemic war (the Second World War, 1939-1945), respectively.

The first and third cycles match entirely: during these cycles, the chaotic non-systemic war dynamics of the System remained undisturbed, as their circular trajectories in phase state already suggest.

The trend line also shows that, in fact, the anarchistic System became more efficient: the severities of the successive cycles exhibit a downward trend, indicating that an increasingly smaller proportion/fraction of the System's population had to be sacrificed to re-establish a functional/optimal order.

015 During the successive cycles of the first finite-time singularity dynamic (1495-1945), the anarchistic System increasingly released free energy through systemic wars instead of non-systemic wars; the release ratio shifted 'in favor' of systemic wars.

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the energy release distribution during the successive cycles shifted in favor of systemic wars. I define the ratio of the severity of a systemic war in a cycle and the total severity of all wars during the cycle as a cycle's release ratio. I consider the severities of wars indicative of the destructive energy that is deployed during wars and of the amount of free energy that has built up and is released.

The change in the energy release distribution can be attributed to the increasing robustness of successive relatively stable periods of cycles. Ultimately, during the fourth relatively stable period (1918-1939), the anarchistic System became completely robust and the release ratio became one, indicating that all the energy was (and could only be) released during the fourth systemic war (the Second World War, 1939-1945).

However, the development of the release ratio indicates a significant distortion during the second cycle (1648-1815).

Release ratios of successive cycles of the actual and theoretical finite-time singularity dynamic (1495-1945). Data based on Levy (38)

		Actual FTS (Severity in BCD)			Theoretical FTS (Severity in BCD)		
Cycle	Period	Severity systemic war	Total severity	Ratio	Severitysystemic war	Totalseverity	Ratio
1	1495-1648	1,971,000	2,976,000	0.66	1,971,000	3,036,000	0.65
2	1648-1815	2,532,000	7,550,300	0.34	4,900,000	5,750,000	0.85
3	1815-1918	7,734,300	8,429,080	0.92	8,100,000	8,720,000	0.93
4	1918-1945	12,948,300	12,953,300	1.00	11,100,000	11,500,000	0.97

Table 24 *This table shows the release ratios of the successive cycles of the actual and theoretical finite-time singularity (1495-1945).*

If the ratios of the actual and theoretical finite-time singularity are plotted in a graph, the (above-mentioned) distortion during the second cycle (1648-1815) is clearly visible.

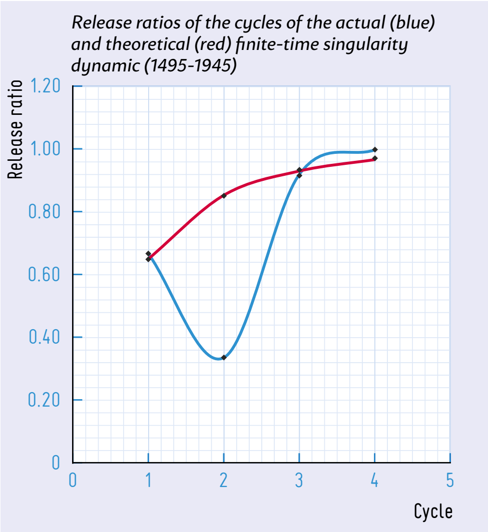


Figure 19
This table shows the release ratios of the successive cycles of the actual (in blue) and theoretical (in red) finite-time singularity that was accompanied by four accelerating cycles (1495-1945). The distortion caused by the first exceptional period is clearly visible (1657-1763).

During the 1657-1763 period, which I designated as the first exceptional period of the second cycle, the non-systemic war dynamics of the System were temporarily non-chaotic in nature and produced a series of extreme non-systemic wars (in terms of size and severity). I argue that these wars resulted because the anarchistic System during that specific period lacked a third – balancing – degree of freedom that would have produced more restrained chaotic non-systemic war dynamics.

The abnormal non-systemic war dynamics during the exceptional period (during the second cycle) had a number of effects, including the following: (1) an 'over-production' of free energy (tensions), resulting in a series of 'extreme' non-systemic wars and hyper-excited war dynamics; (2) a shift in the energy release distribution of the System; and (3) a delay in the unfolding of the second cycle.

1 *Over-production of free energy*

The abnormal non-systemic war dynamics resulted in an increase of 0.92 percent in the total severity of the cycle (see statement 014).

2 *A distortion in the release ratio of the second cycle*

Significantly more energy was released through non-systemic wars during the relatively stable period of the second cycle than would have been the case if the non-systemic war dynamics had not been disturbed, as the theoretical model of the first finite-time singularity dynamic suggests. It seems that the increase in the energy release via non-systemic wars was (at least to a degree) 'compensated' by a significantly lower level of release during the second systemic war (the French Revolutionary and Napoleonic Wars, 1792-1815); the actual release ratio was 0.34 compared to 0.85 for the theoretical release ratio.

3 ***A delay in the unfolding of the second cycle***
This delay was approximately 13 years, as this study suggests.

016 Through systemic wars, the anarchistic System periodically upgraded its order by designing and implementing upgraded organizational arrangements that (1) realigned the actual positions of power and influence among states using the rules that apply to their interactions and (2) were increasingly comprehensive and able to 'handle' the increasing amounts of free energy (tensions) that the System produced as a consequence of its continuously increasing connectivity.

During systemic wars, the System typically addresses two discrepancies that must be corrected: (1) that the preceding international order (which collapsed and caused the System to become critical) is no longer representative and requires an upgrade and (2) that the preceding international order was not designed to 'handle' – to balance – the increased level of free energy that the anarchistic System eventually produced during its lifespan; the anarchistic System continuously produced accelerating amounts of free energy because of its continuously increasing connectivity (populations of states).

1 ***Realigning the actual power and influence of states using the organizational arrangements that underpin international orders***

2 ***.Implementing increasingly integrated international orders***
During the 1495-1945 period, the anarchistic System produced accelerating amounts of free energy (tensions) that had to be put to work (through systemic wars) at an accelerating rate to implement upgraded orders that enabled lower energy states in the anarchistic System. Lower energy states are a prerequisite for relative stability – relatively stable international orders – in the anarchistic System.

Because of the continuously increasing connectivity of the System and the intrinsic incompatibility between connectivity and security in anarchistic systems, the System produced (and continues to produce) accelerating amounts of free energy.

To achieve and maintain lower energy states (at least for some period of time) in a System that produced accelerating amounts of free energy (tensions), the organizational arrangements that underpinned the successive relatively stable periods (international orders) had to be increasingly comprehensive. Interactions between states in the increasingly connected anarchistic System required increasingly comprehensive regulation to ensure that the high levels of tensions that were unavoidably produced could (at least temporarily) be reconciled with the increasing interdependence of the states regarding the fulfillment of their basic requirements.

That increasingly comprehensive arrangements (international orders) had to be implemented facilitated a SIE process in the System; the impulse and instinct of humanity to survive, the need to fulfill basic requirements and the second law of thermodynamics are at the core of the System's SIE dynamic.

017 During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), states and successive international orders coevolved through a powerful-become-more-powerful mechanism.

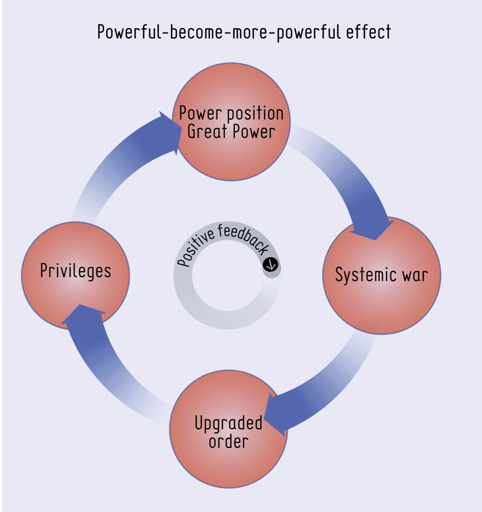
The finite-time singularity dynamic accompanied by four accelerating cycles that unfolded in the anarchistic System during the 1495-1945 period constituted a path-dependent dynamic that increasingly locked in on the accelerating implementation of successive orders to ensure compliance with the second law of thermodynamics. Upgraded orders were implemented during critical periods via systemic wars.

During the unfolding of the finite-time singularity dynamic, the 'units' of the System and successive international orders coevolved; a selection mechanism and self-organization were instrumental in this co-evolution process.

At the core of these dynamics was what I call a 'powerful-become-more-powerful effect'. The powerful-become-more-powerful effect constitutes a self-reinforcing mechanism that contributed to the increasing structural stability of the System and also 'prepared' the anarchistic System to be able to implement dedicated, non-anarchistic hierarchies in its core (Europe).

During systemic wars, states in the System collectively designed and implemented upgraded orders that could ensure the collective fulfillment of the basic requirements of uneven states in the anarchistic System. Systemic wars can be considered bargaining processes: the 'level' of dominance that states achieved during systemic wars determined the extent to which they could influence the design and implementation of the upgraded orders that were about to be implemented. The dominant states used their positions of power and influence during systemic wars to ensure that the arrangements that underpinned the next order promoted their (specific) interests, in particular, which was accomplished by including certain privileges in the upgraded order. These privileges also ensured that the dominant powers had a special interest in maintaining the status quo of the new order, which served them well by virtue of the privileges that were embedded in it. These privileges – and the resulting special interests of dominant Great Powers – contributed to the structural stability of the anarchistic System.

__Figure 20__
This figure shows a causal loop diagram (CLD) of the 'powerful-become-more-powerful effect', which constitutes a positive feedback mechanism. In the CLD, the variables and their relationships are shown: States have 'power positions' that (to a high degree) determine their influence during systemic wars, to ensure the design and implementation of 'favorable' upgraded international orders. Powerful states typically, use systemic wars to acquire (more) privileges that ensure that their basic requirements and interests are secure and promoted during the relatively stable periods (international orders) that follow. As a consequence of this mechanism, powerful states can become increasingly more powerful. This effect contributed to the increase of the structural stability – the organizational permanence – of successive international orders. During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles, shortly before the collapse of the anarchistic System in 1939, the Great Power status dynamics came to a complete halt.



These privileged arrangements also ensured that the dominant powers could extend and increase their dominance through the privileged arrangements. The powerful-become-more-powerful effect contributed to a decrease in the Great Power status dynamics (and to the increasing permanence of the Great Power status hierarchy) during the unfolding of the finite-time singularity dynamic (1495-1945) and contributed to the increasing permanence and fractality of the physical structures of the System. The increasing organizational and physical permanence of the core of the System are a measure of its increasing structural stability.

018 During high-connectivity regimes in relatively stable periods, the connectivity/local stability effect allows the anarchistic System to remain temporarily in a configuration other than the System's state of least energy – in a metastable condition – and 'charge' for systemic war.

During the 1495-1945 period, the anarchistic System produced a finite-time singularity dynamic accompanied by four accelerating cycles. Each cycle consisted of a relatively stable period – an international order – followed by a systemic war; systemic wars are indicative of criticality. During systemic wars, the anarchistic System puts free energy (tensions) to work to implement upgraded orders that foster lower energy states in the System, consistent with the 'demands' of the second law of thermodynamics.

During the relatively stable periods of cycles, two regimes can typically be distinguished: a low- and a high-connectivity regime, which are divided by a tipping point. During low-connectivity regimes, the sizes of non-systemic wars (non-systemic energy releases) are still limited by the 'low' connectivity of the issue network. Once the tipping point of the relatively stable period is reached, the increasing connectivity of the network of issues results in the (increasing) local stability of the states in the network; this so-called connectivity/local stability effect increasingly limits the sizes of non-systemic wars.

The impact of abnormal, non-systemic war dynamics during the first exceptional period (1657-1763) on the development of the second cycle (1648-1815) suggests that for a relatively stable period to reach the threshold for a high-connectivity regime, the non-systemic war dynamics must be chaotic in nature and must not be periodic or as extreme as was the case during the first exceptional period. As opposed to periodic war dynamics, chaotic war dynamics are more restrained because of a third degree of freedom that impacts these dynamics.

During high-connectivity regimes, free energy (tensions) is 'stored' in the anarchistic System instead of being released, which then forms a free energy release deficit, which results in the energy crystallizing in vulnerable issue clusters with fractal structures. The moment these clusters percolate through the System, the System becomes critical and produces a systemic war. At that point, the percolated vulnerable issue clusters are activated, and the free energy release deficit is released.

High-connectivity regimes (in combination with chaotic, non-systemic war dynamics) are a precondition for criticality and systemic war: high-connectivity regimes constitute thresholds that allow the anarchistic System to remain – for the duration of the high-connectivity regime – in a configuration other than the System's state of least energy (in a metastable condition) and to 'charge' for the next systemic war.

019 High-connectivity regimes, in combination with chaotic, non-systemic war dynamics, are preconditions for the anarchistic System to become critical and to produce systemic wars to implement upgraded orders.

This study shows that chaotic, non-systemic war dynamics during high-connectivity regimes are a precondition for the anarchistic System to become critical and produce systemic wars: The System must be 'charged'.

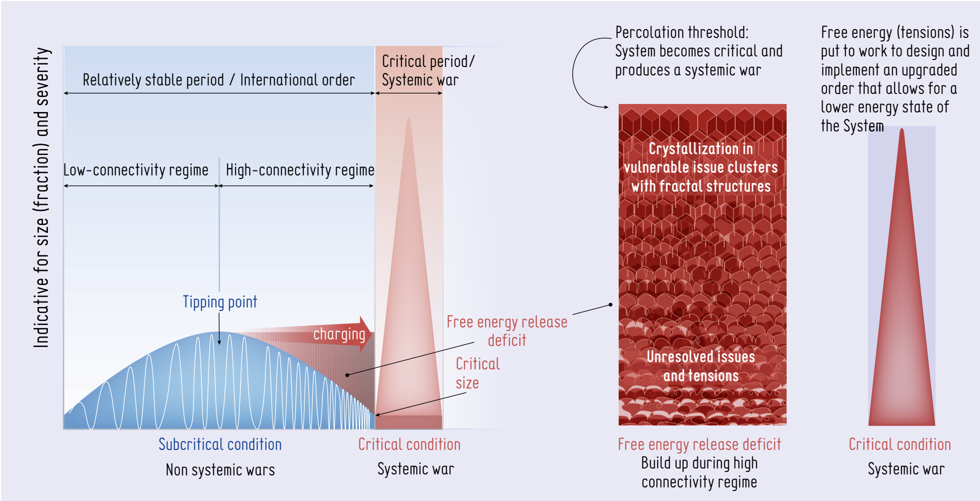


Figure 21 *This figure shows schematically the buildup of a free energy release deficit during the high-connectivity regime of a relatively stable period (international order). The free energy (unresolved issues and tensions) is temporarily 'stored' in the System, and crystalizes in vulnerable issue clusters. The moment these clusters percolate the System, the System becomes critical and produces a systemic war. During the systemic war the accumulated free energy (tensions) is put to work to implement an upgraded order that allows for a lower energy state of the System.*

During critical periods, free energy (tensions) that has accumulated in the System is put to work to implement upgraded orders that foster lower energy states in the System, consistent with the requirements of the second law of thermodynamics. Critical periods/systemic wars are instrumental in the development of the System to ever-higher levels of order.

Chaotic, non-systemic war dynamics are a precondition for the anarchistic System to become critical. The intrinsic inhibition of chaotic war dynamics contributes to 'charging' the System during high-connectivity regimes.

The 'inhibition' of chaotic, non-systemic wars can be attributed to the impact of a third (or fourth) degree of freedom. A third degree of freedom has a balancing effect. In cases in which the System has at least three degrees of freedom, states are more reluctant to engage in war because of the greater unpredictability of the System under those particular (chaotic) conditions. Unpredictability is synonymous with risk and thus for restraint. During the first exceptional period (1657-1763), the number of degrees of freedom within the System was temporarily reduced to two as a consequence of the intense rivalry between Britain and France; tension levels in the System were very high. The System as such was transparent ('simple', i.e., all issues were dominated by the intense rivalry between Britain and France), easier to understand, and more predictable; therefore, it was not considered necessary (or possible) to hedge risk. Because of these 'simplified' conditions, issues became over-connected, and the System became hyper-excited, resulting in more extreme non-systemic wars in terms of size as well as severity/intensity.

High-connectivity regimes (in addition to chaotic, non-systemic war dynamics) are also a precondition for the anarchistic System to become critical. The connectivity/local stability effect that manifests during high-connectivity regimes increasingly 'inhibits' non-systemic war dynamics (non-systemic energy releases).

During high-connectivity regimes, instead of being released, free energy (issues and tensions) is 'stored' in the System; this energy forms a free energy release deficit and crystalizes in vulnerable issue clusters with fractal structures. The moment these vulnerable issue clusters percolate through the System, the System becomes critical and produces a systemic war.

The intrinsic inhibition of both chaotic, non-systemic war dynamics and high-connectivity regimes is necessary to charge the System for systemic wars.

Following the dual-phase transition (the fourth systemic war, the Second World War, 1939-1945), the anarchistic System developed a second finite-time singularity dynamic accompanied by accelerating cycles.

The System is in a high-connectivity regime, and the non-systemic war dynamics are chaotic in nature, as their circular trajectories in phase state show; the System is – because that is what it means – now 'charging' for the next systemic war.

Free energy (tensions, unresolved issues), the release of which is increasingly inhibited, are instead stored within the System and form a free energy release deficit. The stored free energy crystallizes in vulnerable issue clusters that will eventually – in approximately 2020 – percolate through the System, causing it to become critical and to produce a systemic war to implement an upgraded order that fosters a lower energy state in the System, that is, the next relatively stable period.

020 It is possible to distinguish seven types of change within the System.

This study shows that seven types of change can be distinguished within the deterministic domain of the anarchistic System; these types of change can be derived from the workings of the finite-time singularity dynamic that was accompanied by four accelerating cycles (1495-1945). In all seven cases, the changes were not caused by exogenous factors but resulted from the intrinsic dynamics of the anarchistic System.

1 ***A change from a collection of unconnected units to a system***

This change was accomplished when a collection of unconnected units reached the percolation threshold around the year 1495. These units became connected and formed an 'integrated' system.

The accompanying mechanism of change was connectivity growth through population growth. This change affected the System.

2 ***A change in the fundamental structure of the System: the merging of nodes in dedicated, non-anarchistic hierarchies***

This change was accomplished in the core of the System, when the System reached the critical connectivity threshold in 1939, then collapsed and experienced a dual-phase transition. The dual-phase transition resulted in the implementation of two dedicated, non-anarchistic hierarchies in the core (Europe) of the System and the first global order on a global scale in the System (see change (7)). Within these dedicated hierarchies, anarchy and the production of free energy were neutralized, ensuring limits on the production of free energy (tensions) in the anarchistic System (consistent with the second law of thermodynamics).

The accompanying mechanism of change was a (dual) phase transition. Because it was a phase transition, it required criticality and became manifest in the contingent domain through the fourth systemic war (the Second World War, 1939-1945). This change affected the System.

3 ***A change in the order of successive relatively stable periods***

During the unfolding of the singularity dynamic, upgraded orders were implemented via systemic wars three times. Upgraded orders provided increased structural stability and (renewed) opportunities for states to fulfill their basic requirements.

The accompanying mechanisms of change were criticality in the deterministic domain and systemic war in the contingent domain. This change also affected non-systemic war dynamics between states during successive relatively stable periods (international orders).

4 ***Change from a low- to a high-connectivity regime during relatively stable periods***

At the tipping points during the life cycle of relatively stable periods (dividing low- and high-connectivity regimes), states in the System reached a degree of connectivity that resulted in increased local stability and limited the size of the non-systemic wars that the System could produce. High-connectivity regimes (increasingly) deprived the System of the option to release tensions by means of non-systemic wars and instead resulted in the accumulation of free energy release deficits that crystalized in vulnerable issue clusters with fractal structures. The vulnerable issue clusters eventually percolated the System, leading it to become critical and to produce a systemic war to restore a viable level of order.

The accompanying mechanism of change was increasing connectivity. The change affected (1) the size of the non-systemic wars that the System could produce during relatively stable periods, (2) the free energy that could be stored in the System (the 'size' of the free energy release deficit), (3) the formation of vulnerable clusters, (4) the System's criticality, and (5) the System's ability to implement upgraded orders via systemic wars.

5 ***Change from a high-connectivity regime to criticality and systemic war***
During the final stage of high-connectivity regimes in relatively stable periods, vulnerable issue clusters eventually percolated through the System, causing it to become critical. A critical condition means that the correlation length of the System had reached 'one'; a condition that allowed for system-wide communication, coordination and planning. At that point, the System's susceptibility to disruptions had also become infinite, meaning that even small incidents could trigger systemic responses (systemic war). The 'outbreak' of the third systemic war (the First World War, 1914-1918) illustrates these typical system properties and dynamics. When the percolating vulnerable issue cluster was triggered – activated – the condition of the System then abruptly changed from what could be defined as a stable condition to systemic war.

The accompanying mechanism of change was increasing connectivity and a percolating vulnerable cluster that triggered a system-wide response. The change affected the level of war in the System, altering it from an absence of non-systemic wars, which were effectively suppressed by the local stability of states as a consequence of the high connectivity of the System, to systemic war. This change allowed the System to implement upgraded orders by means of systemic wars.

6 ***A change from chaotic to periodic, non-systemic war dynamics, and vice versa***
During the unfolding of the (first) finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the anarchistic System experienced two bifurcations: a bifurcation from a chaotic to a periodic regime (1657) and vice versa (1763).

During the first exceptional period (1657-1763), the non-systemic war dynamics were more consistent and more extreme, contrary to the intrinsically unpredictable and more restrained war dynamics observed during periods of chaotic conditions. The accompanying mechanism of change was a temporary change in the number of degrees of freedom (n) in the System; $n > 2$ implies chaotic dynamics, whereas $n = 2$ implies periodic conditions. The intensity of the rivalry between states in the System determined how many states – variables, degrees of freedom – were taken into account in war decisions.

The first exceptional period can also be understood as a 'periodic window' that the anarchist System temporarily encountered when (in 1657) the System retreated from chaos as a consequence of a decrease in the number of degrees of freedom in the System.

The change affected the nature of the non-systemic war dynamics of the System. Extreme and more frequent wars occurred under the periodic dynamic conditions ($n = 2$) than under the more restrained and intrinsically unpredictable wars that occurred under chaotic dynamic conditions ($n > 2$). The periodic war dynamics delayed the accumulation of a free energy release deficit and the crystallization of this energy (tensions) in vulnerable issue clusters with fractal structures. Consequently, the System was delayed in reaching criticality, in producing the next systemic war, and in implementing an upgraded order. Extreme non-systemic wars during the first exceptional period (1657-1763) negatively affected the development and unfolding – and the efficiency – of the finite-time singularity dynamic.

7 ***A change in the relationship of the System (its core) with its environment (non-core);*** *the* ***merging of core and non-core***

In 1939, the core of the System (Europe) reached its critical connectivity threshold and consequently produced an infinite amount of free energy (tensions); in response, the core of the System became critical. In December 1941, as a consequence of Japan's attack on the United States (Pearl Harbor, 7 December 1941) and Germany's declaration of war on the United States (11 December 1941), vulnerable issue and war clusters in the non-core linked with the critical core. At that point, the System became critical on a global scale.

December 1941 marks the globalization of the System and the merging of the core and non-core of the (now global) System. To ensure consistency with the second law of thermodynamics, the System produced a dual-phase transition (by means of the fourth systemic war, the Second World War, 1939-1945), which resulted in the simultaneous implementation of two dedicated, non-anarchistic hierarchies in the core of the System and the first global order on a global scale in the System; the European order had now merged with and become an integral part of a global order.

In the table below, I show the seven deterministic changes and their respective contingent counterparts.

Deterministic changes and contingent counterparts		
	Change in the deterministic domain	Contingent counterpart/equivalent
1	A change from a collection of unconnected units to a system.	Units (states) became interconnected; different parts of the System began interacting and influencing one another; information and tensions could be transmitted through the System.
2	A change in the fundamental structure of the System: the merging of nodes in dedicated, non-anarchistic hierarchies.	A change from anarchy to non-anarchy in the respective dedicated hierarchies.
3	A change in the order of successive relatively stable periods.	Implementation of increasingly far-reaching organizational rule sets that underpinned successive international orders.
4	Change from a low- to a high-connectivity regime during relatively stable periods.	During low-connectivity regimes, an increase in the average size of non-systemic wars; during high-connectivity regimes, a decrease in the average size of non-systemic wars.
5	A change from a high-connectivity regime to criticality and systemic war.	An abrupt change from the relative absence of non-systemic wars to systemic war.
6	A change from chaotic to periodic, non-systemic war dynamics, and vice versa.	A change from relatively constrained and intrinsically unpredictable non-systemic wars to more predictable non-systemic wars that were also more extreme in size (fraction) and severity (in terms of BCD).
7	A change in the relationship of the System (its core) with its environment (non-core); the merging of core and non-core	A change from a core and non-core configuration of the System to an overarching global order that included the (upgraded) European order.

Table 25 *This table shows the deterministic changes and their equivalent counterparts in the contingent domain.*

021 The first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) constitutes a distinct phase in the long-term process of social integration and expansion that is still unfolding.

The first finite-time singularity dynamic accompanied by four accelerating cycles that unfolded in the anarchistic System during the 1495-1945 period constitutes a simultaneous process of integration – at the core of the System, in Europe – and expansion of core states to the non-core. When the core of the System reached its critical connectivity threshold (the singularity in finite time) in 1939, the core of the anarchistic System produced an 'infinite' amount of free energy (tensions) and consequently collapsed.

In 1941, the critical core 'linked' with war and issue clusters in Asia, causing global criticality.

In response, the System produced a dual-phase transition, and simultaneously – via the fourth systemic war (the Second World War, 1939-1945) – two dedicated, non-anarchistic hierarchies that were implemented in the core of the System (Europe) and the first global order in the System. The dual-phase transition – the two complementary orders that were implemented – fostered a lower energy state in the (now global) anarchistic System, consistent with the demands of the second law of thermodynamics.

The finite-time singularity accompanied by four accelerating cycles (1495-1945) can be understood as a distinct phase in the long-term SIE process that is still unfolding.

I now discuss the different 'components' of this SIE dynamic.

1 *Formation and integration of the core*

During the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the core of the System (Europe) developed from a large collection of loosely connected and diverse units (in 1495) into a highly integrated anarchistic System consisting of 25-30 highly standardized states (in 1939). Systemic wars, which defined the System and its cycles, were responsible for this development; these systemic wars were manifestations of the criticality of the System. Through systemic wars, the anarchistic System put free energy (tensions) to work to implement upgraded orders that fostered lower energy states in the System, consistent with the demands of the second law of thermodynamics. The System became critical – and produced upgraded orders – at an accelerating pace.

The properties of the accelerating cycles developed very consistently. As the units/states in the System crystalized into a highly integrated anarchistic System consisting of 25-30 highly standardized states, the structural stability, robustness and fragility of the System simultaneously increased linearly; these properties reached 'infinity' during the fourth relatively stable period (the fourth international order, 1918-1939), shortly before the System's collapse. Furthermore, during this crystallization process (1495-1939), the physical structure (the territories of states) of the System became increasingly fractal, a development that also contributed to the System's 'brittleness'. This process was inseparably linked to the collapse of the core of the System in 1939.

When the System reached its critical connectivity threshold (the singularity in finite time (in its core, Europe) in 1939, it produced an infinite amount of free energy (tensions) as a consequence of the (now infinite) incompatibility between connectivity and security in the anarchistic System.

Because the core of the anarchistic System now produced an infinite amount of free energy (was 'infinitely incompatible'), it was no longer possible to achieve a lower energy state (consistent with the demands of the second law of thermodynamics) by implementing an upgraded order in the anarchistic System: The System had reached its anarchistic end state.

Consequently, the anarchistic System (its core) collapsed. In the core of the System (Europe), the demands of the second law of thermodynamics could be met only by reducing the level of anarchy. This objective was accomplished by implementing two dedicated, non-anarchistic hierarchies in its core: A Western non-anarchistic hierarchy controlled by the United States and an

Eastern non-anarchistic hierarchy controlled by the Soviet-Union. Within these respective hierarchies, anarchy was neutralized, resulting in a reduction in the (total) amount of free energy that the System produced (at least temporarily).

The process of integration – the prelude to the core of the System (Europe) becoming critical and experiencing a phase transition (to two dedicated, non-anarchistic hierarchies) – was closely related to a simultaneous process of expansion to the non-core (and vice versa).

2 *Expansion to and of the non-core*

As the core of the anarchistic System became increasingly integrated through a finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the core of the System (Europe) simultaneously expanded to the non-core. The war dynamics of the System also reveal that there was a simultaneous process of expansion of the core to the non-core, resulting in their eventual merging (1941-1945).

It is possible to distinguish five phases in the expansion process.

Five phases of expansion from a European to a global System

Phase	Timing	Characteristics	Triggers
(I) Core formation and integration: Initially (1495-1812): 'Internal core dynamics only'	Starting 1495	During the period 1495-1812 all Great Power war dynamics still take place within Europe, the core of the System.	During the period 1495-1812; internal core dynamics only.
(II) Core expansion: 'Power projection outside Europe'	Starting 1812	European Great Powers become involved in or start wars outside of Europe.	The War of 1812, 1812-1814, war 88 in Levy's data-set marks the beginning of this phase. Other wars that are part of phase two are 97, 99, 104, 105, 110, and 112 (38).
(III) Autonomous non-core formation and involvement in European affairs	Starting 1914	Non-European Great Powers become involved in European war dynamics.	The United States' and Japan's involvement in the First World War (1914-1918) mark the beginning of this phase.
(IV) Non-European powers autonomously produce their own war dynamics	Starting 1931	Non-European Great Powers initiate their own Great Power wars outside of Europe, without the direct involvement of European Great Powers.	The Manchurian War (109, involving Japan and China) marks the beginning of this phase.
(V) Globalization of the System and merging of core and non-core	Starting 1941	War dynamics become connected on a global scale.	Japan attacks the United States (Pearl Harbor, 1941), and Germany (ally of Japan), declares war on the United States, connecting war clusters in Europe and Asia.

Table 26 *This table shows the five expansion-phases of the System that can be determined during the unfolding of the finite-time singularity dynamic (1495-1945).*

I argue that the processes related to the integration of the core (Europe), the core's expansion to the non-core, and the eventual merging of the core and non-core through a dual-phase transition (the fourth systemic war, the Second World War, 1939-1945), were processes that reinforced one another.

By expanding to the non-core, European states attempted to enhance their capacity to (better) fulfill their basic requirements and achieve more power and influence to 'position' themselves in core dynamics (in relation to other European states in Europe). The expansion of core states to the non-core can be considered an energy 'input' for the core of the System; however, this input/import of energy into the core of the System was accompanied by exporting rivalries among European states to the non-core. It was only a matter of time before the non-core developed its own 'autonomous' free energy (tensions), which led to the import of non-core free energy into the core.

I assume that the process of integrating the core was reinforced by the process of expansion to the non-core, and vice versa.

3 *Synchronization and mutual reinforcement*

An analysis of war data shows that the process of integration in the core (Europe) and the core's expansion to the non-core were highly synchronized, not only from a 'functional' perspective (such as in the self-reinforcing nature of the integration/expansion processes) but also with respect to the pace at which both processes unfolded; both processes unfolded at exactly the same pace.

Accelerating expansion of the System (1495-1941)		
Phase	Start date	Time to globalization (1941 - start date)
(I) Core formation and integration	1495	446
(II) Core expansion	1812	129
(III) Autonomous non-core formation and involvement in European affairs	1914	27
(IV) Non-European powers autonomously produce their own war dynamics	1931	10
(V) Globalization of the System and merging of core and non-core	1941	0

Table 27 *This table shows the accelerating expansion of the System (1495-1941).*

Cycles and phases related to the process of integration and expansion (SIE) of the anarchistic System (1495-1945)				
		Integration T(c) = 1939		Expansion T(c) = 1941
Cycle/Phase	Start T	T(c) - T	Start T	T(c) - T
1	1495	444	1495	446
2	1648	291	1822	129
3	1815	124	1914	27
4	1918	21	1931	10

Table 28 *In this table I show how I determined the duration of successive (integration) cycles and expansion phases. The critical time (T(c)) for the process of integration is the timing of the anarchistic System's collapse in 1939; The critical time for the process of expansion is 1941, when the System 'globalized' through the global linkage of war and issue clusters.*

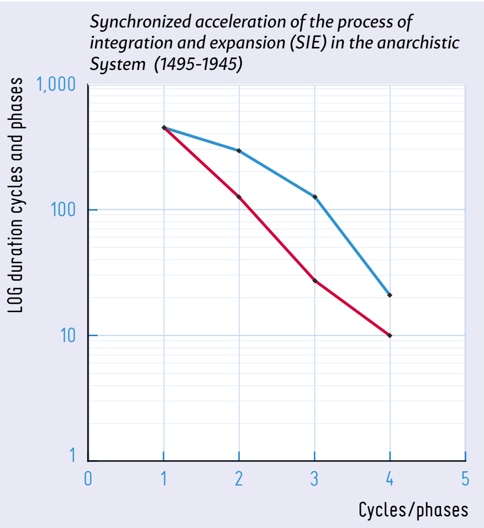


Figure 22
This figure shows the acceleration of the processes of integration (blue) and expansion (orange) in the anarchistic System. The data points related to the process of integration (blue) depict the life-spans of successive cycles (that can be considered 'phases of integration' in the core). The data points related to the process of expansion (red) depict the duration of the four phases that can be distinguished in the process of expansion of the core to the non-core. The figure shows that both processes accelerated at about the same rate. It not only confirms the close relationship between both processes, and was to be expected given the fact that both processes originated in the core of the System (Europe), and that the pace of these processes is determined by the level of connectivity of the core, itself a function of its population size. Population growth, in other words, set the pace for integration, as well as expansion in the System. The correlation coefficient of the series is 0,92.

The above figure shows that both processes unfolded at exactly the same pace, which is of course no coincidence, as the 'same' connectivity growth (population growth) of the System is responsible for both processes. These processes are two 'dimensions' of the SIE process.

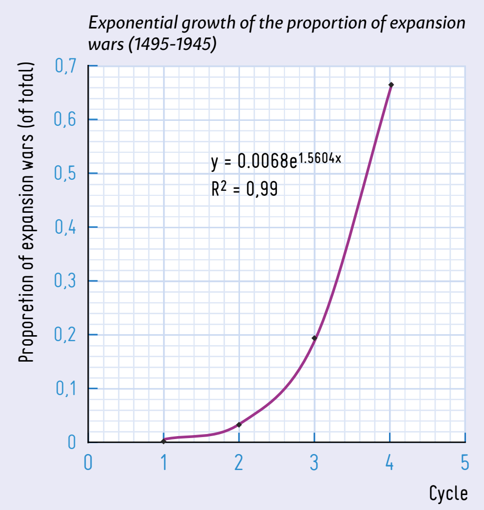
During the fourth systemic war (the Second World War, 1939-1945), the core (Europe) and non-core of the System merged into a global system with a global order. At that point, the synchronization of the core and non-core (also) became 'absolute', and, in fact, the distinction between the core and non-core of the System had become obsolete.

An analysis of the war data reveals not only that the processes related to the integration of the core and expansion to the non-core were synchronized and mutually reinforcing but also that the proportion of expansion wars during the successive cycles of the first finite-time singularity dynamic increased at an exponential rate.

Proportion of expansion wars (1495-1945)			
Cycle	Non-systemic wars (total)	Expansion wars	Proportion (Expansion wars)
1	45	0	0.000
2	34	1	0.029
3	21	4	0.190
4	6	4	0.667

Table 29 *This table shows the proportion of expansion wars during successive cycles of the first singularity dynamic (1495-1945).*

Figure 23
This figure shows the exponential growth of the proportion of expansion wars during successive cycles of the first finite-time singularity dynamic (1495-1945).



4 *Merging of core and non-core*

During the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles, the dynamics of the core (Europe) and the non-core were (increasingly) synchronized. The war dynamics also illustrate that the non-core increasingly developed its own autonomous rivalries and tensions that were not (directly) related to the core.

Through the fourth systemic war (the Second World War, 1939-1945), the anarchistic System simultaneously implemented two dedicated, non-anarchistic hierarchies in the core of the System (Europe) and the first global order in the System.

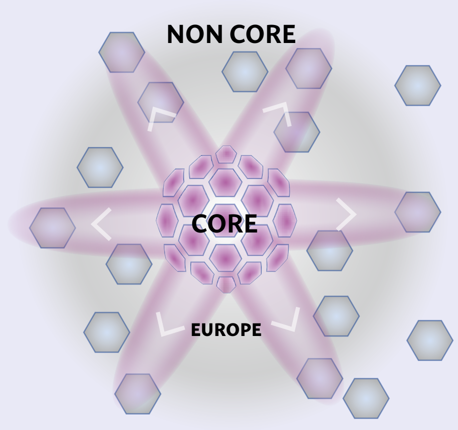
Preceding this dual-phase transition, the synchronization of the process of integration and expansion was accomplished via the political control of European states over non-core territories (their colonies). According to Tilly

(70), "European states held political control over approximately 7 percent of the earth's land in 1500, 35 percent in 1800, and 84 percent in 1914."

At the time of the collapse of the core of the System (1939), the core became critical, and a systemic war developed in Europe. At approximately the same time, however, the non-core also reached criticality. The moment that Japan attacked Pearl Harbor in the United states (7 December 1941) and Germany declared war on the United States on 11 December 1941, the vulnerable issue and war clusters of the core and non-core became connected, and the System became critical on a global scale (for the first time). At that point, the core and non-core in fact merged. The function of systemic wars is to re-establish order; during systemic wars, free energy (tensions) that has accumulated in the System is put to work to implement upgraded orders that enable lower energy states in the System, consistent with the second law of thermodynamics.

Because the core and non-core had now merged, the next upgraded order had to address free energy production in Europe (with its high level of integration) and on a global scale in the System. Because of the different levels of development of Europe and the global System (of which European states had become integral parts, equivalent to non-core states) and to ensure compliance with the second law of thermodynamics, two upgraded orders – one in Europe and one on a global scale – were implemented; these two orders were complementary.

The 'coordination' between the design and implementation of both orders was accomplished by the United States and the Soviet Union. Through the fourth systemic war (the Second World War, 1939-1945), the United States and the Soviet Union had achieved a dominant position on a global scale in the System and in Europe by establishing de facto control over Western and Eastern Europe, respectively.



Lynchpin-model < 1939: 'Inside/out'

Main characteristics:

~ Distinction between a core (Europe) and non-core
~ Core states control non-core
~ Core and non-core war dynamics are normally chaotic in nature

Figure 24 *In this figure the linking of core and non-core is shown before the collapse of the System in 1939. Core-states controlled (most of) the non-core territories through colonies they had acquired.*

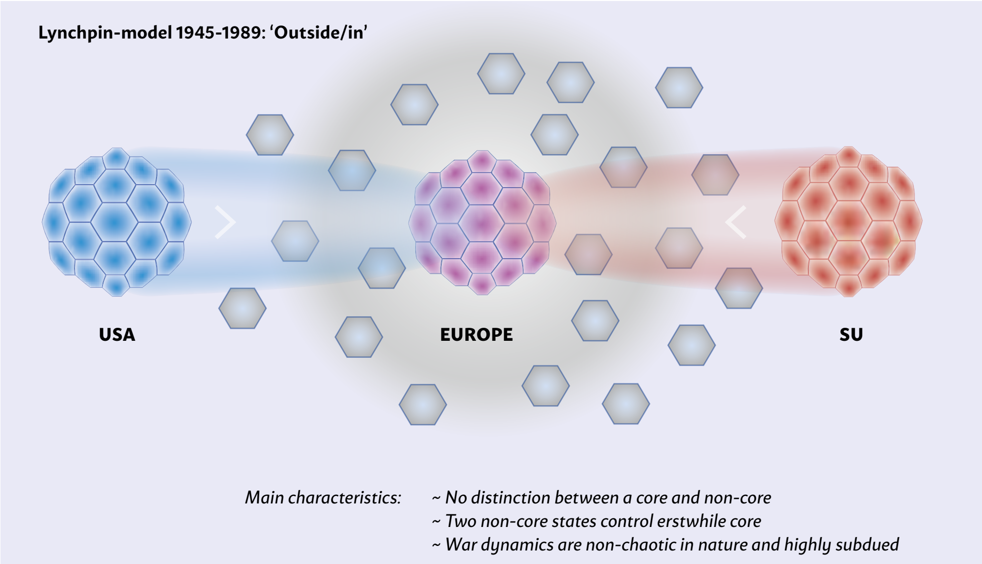


Figure 25 *In this figure the linking of the 'European order' - consisting of two dedicated non-anarchistic hierarchies, respectively controlled by the United States (the Western hierarchy) and the Soviet Union (the Eastern hierarchy) - to the first global order is shown. Both hierarchies (the European order) were integral parts of the first global order; core and non-core had merged through the fourth systemic war (the Second World War, 1939-1945).*

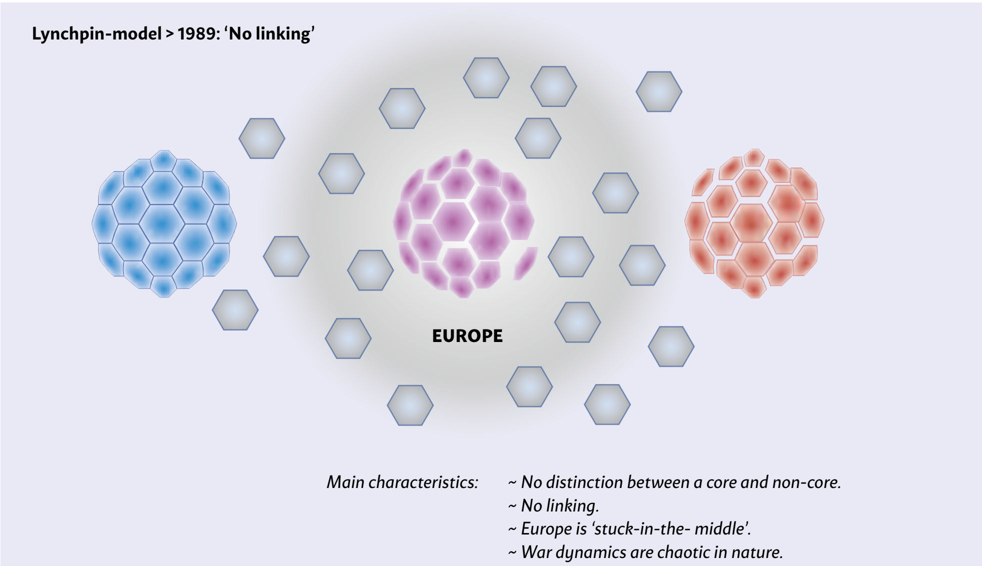


Figure 26 *In this figure the System is shown after the collapse of the Eastern hierarchy, and the 'abolition' of the lynchpin model (1945-1989). European states and the European Union are stuck-in-the-middle, and are 'on drift'.*

5 ***Decoupling of Europe in 1989: the end of the dual-link model***
In 1989, the Eastern hierarchy collapsed. The intense rivalry between the United States and the Soviet Union (1953-1989) that led to the second exceptional period (1953-1989, the Cold War) came to a halt, and the anarchistic System resumed chaotic, non-systemic war dynamics.

Resolution of the intense rivalry between both 'superpowers' resulted in the disintegration of the former Soviet republics and in the 'merging' of the states of the former Eastern hierarchy with those in the Western hierarchy into what would evolve (further) into the European Union.

However, the United States as well as the Soviet Union – Russia – disengaged from Europe (as a consequence of the collapse of the Soviet Union). The 'lynchpin' functions of both Powers – linking the European order (consisting of two dedicated non-anarchistic hierarchies) to the global System – were no longer 'functional'; now, both dedicated hierarchies could be – and were – integrated.

The question is now whether – considering that chaotic, non-systemic war dynamics have resumed on a global scale since 1989, that Europe is 'unlinked' (from the United States and the Soviet Union), and that Europe as a single, dedicated, non-anarchistic order is still 'stuck-in the-middle' (has not yet fully crystalized as an effective integrative structure, while states in Europe have lost autonomy) – the European Union can be effective at ensuring the fulfillment of the basic requirements of its diverse populations given the challenges with which the global anarchistic System and Europe are now confronted.

This issue – question – must be viewed from the perspective that the current relatively stable period (the current international order, 1945-...) is in its high-connectivity regime (2011 was the tipping point). Because of the connectivity/local stability effect during high-connectivity regimes, the System is increasingly inhibited in its release of free energy (tensions); instead of being released, free energy is stored in the System (where it forms free energy release deficits) and crystalizes in vulnerable issue clusters with fractal structures. Eventually, the vulnerable issue clusters will percolate through the global System, causing it to become critical and to produce a systemic war to implement an upgraded order that will enable lower energy states in the System, which is consistent with the second law of thermodynamics.

This study's calculations suggest that the current international order will become critical in approximately 2020 and produce a second global systemic war to implement a second global order that will again foster a lower energy state in the System.

022 The urge to survive drives the process of social integration and expansion.

Humanity's urge to survive drives the SIE process. To survive, humans must fulfill a set of basic requirements. Humans and social systems can achieve economies of scale and scope in fulfilling basic requirements through interactions (exchanges) and cooperation with other people and social systems (such as tribes, states, and so forth).

Interactions between people and social systems can be regulated by implementing shared organizational arrangements (orders). The production of tensions can be prevented by implementing dedicated, non-anarchistic hierarchies. To be effective as an integrated hierarchy (coherent social system), it must meet a number of conditions; including:

1) Share a number of basic values.
2) Define shared goals (the components of the hierarchy (states) must have a shared understanding of the desired direction of development of the hierarchy).
3) Achieve consensus over its current condition and challenges.
4) Collectively define actions and priorities.
5) Ensure requisite variety (ensure that adequate responses to perturbations are available, in time).

The social law that drives the SIE process consists of five components:

1) The need for humans to fulfill basic requirements to ensure their survival.
2) Population growth.
3) Economies of scale and scope can be achieved in fulfilling basic requirements by interacting and cooperating with other people and social systems.
4) Tensions between actors can be regulated by implementing shared organizational arrangements.
5) The production of free energy (tensions) can be prevented through integration in non-anarchistic structures.

023 Assessment of the dynamics and development of the current (now global) anarchistic System.

With the help of consistencies in the dynamics and development of the anarchistic System during the 1495-1945 period – during which the first finite-time singularity dynamic accompanied by four accelerating cycles unfolded – a number of deterministic and contingent indicators can be identified that provide clues for assessing the current condition of the System and for predicting the dynamics and further development of the current international order (1945-...).

Regarding the assessment and prediction of the dynamics and development of the current anarchistic System, I draw a distinction between deterministic and contingent indicators: I assume that deterministic laws and mechanisms shape the (contingent) dynamics and development of the System.

In the table below, I discuss a set of deterministic indicators and their current 'condition'.

The following deterministic indicators can be identified:

	Deterministic indicators for assessment and prediction		
	Indicator	Clarification	Assessment
1	Rate of population growth.	Determines the free energy that will be produced in the System and its connectivity.	Projected population growth is sufficient to power a second singularity dynamic (1945-…), at least until the early 22nd Century.
2	The number of degrees of freedom in the System.	Determines whether non-systemic war dynamics are chaotic or non-chaotic. Chaos is a precondition for the System to form underlying vulnerable issue clusters and to become critical.	The number of degrees of freedom in the System since 1989 is at least three; non-systemic wars are chaotic in nature.
3	Average size of non-systemic energy-releasing wars.	Determines if the System is in a low- or high-connectivity regime.	The (average) size of non-systemic wars is decreasing, suggesting the current international order (relatively stable period) is in its high-connectivity regime.
4	Development of the frequency of non-systemic energy releases.	Determines if the System is in a low- or high-connectivity regime.	Cannot be established at this stage.
5	Changes in the centrality of nodes (development of Great Power status dynamics).	The indicator of the structural stability – organizational permanence – of the System.	Great Power status dynamics, indicative of changes in the centrality of nodes in the System, have resumed; organizational permanence is not absolute (anymore).
6	Changes in the size and form of nodes (states).	The indicator of the structural stability – permanence of political control – of the System.	The sizes and forms of certain nodes change; the physical structure of the System is not absolute (anymore).
7	The nature of the size distribution of states in the System; the level of fractality of the System.	The indicator of the performance of the System and the efficiency of free energy production and (re)distribution in the System.	Cannot be determined at this stage.
8	Robustness of the System.	Determines the System's sensitivity to disruptions and its ability to release free energy by means of non-systemic release events. This property is closely related to the System's fragility.	The System produces non-systemic energy releases (non-systemic wars); its robustness is not absolute. This implies that the next systemic war will not constitute a phase transition.
9	Fragility of the System.	Determines the lifespan of relatively stable periods. This property is closely related to the System's robustness.	The fragility of the System is not absolute, see also indicator 8 (concerning the robustness of the System).

Deterministic indicators for assessment and prediction			
10	The durations of relatively stable periods and of critical periods (the lifespan of international orders and systemic wars, respectively).	Indicator of the connectivity and pace of life of the System. Decreasing durations indicate that the System is approaching the critical connectivity threshold.	Cannot be determined at this stage.
11	The amount of destructive energy that is deployed during critical periods, for which the severity and intensity of systemic wars are indicators.	Indicator of the connectivity and pace of life of the System. Increasingly higher – and ultimately infinite – amounts of destructive energy means the System is approaching the critical connectivity threshold.	Cannot be determined at this stage.
12	The rate of acceleration of the System.	The indicator of the connectivity and pace of life of the System. Increasing and ultimately infinite acceleration indicates that the System is approaching its critical connectivity threshold.	Cannot be determined at this stage.

Table 30 *This table shows the assessment of deterministic indicators.*

Based on the above assessment of a number of deterministic indicators – and assuming that the extension of Levy's database (1495-1975) is accurate – the 'condition' of the current System is as follows:

1) ***Conditions indicate a second singularity dynamic.*** The current (global) anarchistic System is a product of a dual-phase transition (of the fourth systemic war, the Second World War, 1939-1945) and meets the conditions to produce a second singularity dynamic.

2) ***Population growth.*** Population growth is sufficient to 'power' the second singularity dynamic (1945-...), at least until the early 2$^{\text{n}}$d Century.

3) ***First cycle.*** Currently, the second singularity dynamic is in its first cycle.

4) ***Tipping point.*** In 2011, the current international order (relatively stable period) reached its tipping point.

5) ***High-connectivity regime.*** Currently, the international order (relatively stable period) is in a high-connectivity regime.

6) ***Decrease in war sizes.*** The (average) size of non-systemic wars is now decreasing as a consequence of the connectivity/local stability effect, while the frequency of non-systemic wars will increase.

7) ***Conditions for criticality.*** The System now meets the prerequisites to become critical and to produce a systemic war: a combination of chaotic non-systemic war dynamics during a high-connectivity regime.

8) ***Free energy storage and crystallization.*** Instead of being released, the free energy (tensions and unresolved issues) produced by the current international order is now stored in the System (and forms a free energy release deficit) and – I assume – is crystalizing in vulnerable issue clusters with fractal structures that will eventually percolate through the System, causing it to become critical and to produce a systemic war.

During the next systemic war, free energy (that is now stored) will be put to work to implement an upgraded order that will foster a lower energy state, the next relatively stable period in the System. The System, in other words, is now 'charging' for the next systemic war.

As I discuss in part IV it is also possible to identify a number of contingent indicators that might be helpful in assessing the current dynamics and (direction of) the development of the System. However, this study also shows that the prediction of war dynamics and the development of the System on the basis of contingent indicators is problematic. The development of the power flux and alliance dynamics, for example, are of no practical value; due to their short lead-time they are not reliable early warning signals.

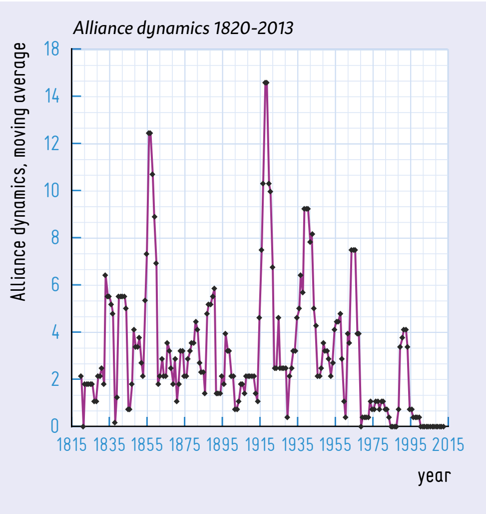
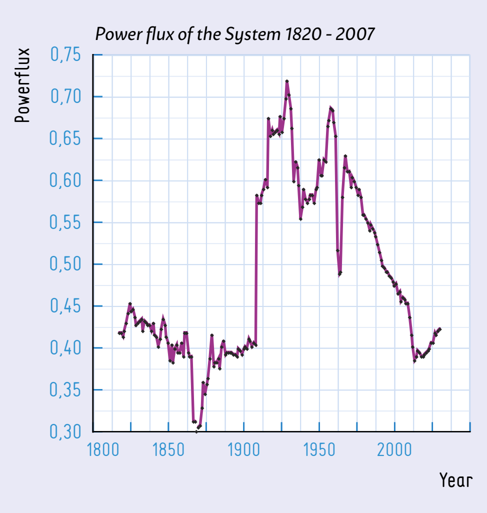


Figure 27
This figure shows the alliance dynamics of the System as the moving average (five observations) of the sum of alliances started or ended by Great Powers in the System in increments of five years during the period 1820-2013 (25).

A number of issues that act as crystallization points for tensions in the contingent domain can be identified. In general terms, these issues are as follows: (1) Russian expansion in Eastern Europe (involving Russia, Europe, and the United States); (2) Religious and Great Power rivalries in the Middle East (involving a number of regional powers, such as Iraq, Iran, Syria, Turkey, Israel, among others, as well as Europe, the United States and Russia); (3) Chinese expansion in the South China Sea (involving the United States, and (probably) Russia) in addition to China and a number of regional states, such as the Philippines, Vietnam, and others; and (4) North Korea's defiance of the international order (involving the United States, China, and Russia).

These contingent dynamics can change, as far as the contingent latitude (deterministic laws) of the System allows.

Figure 28
This figure depicts the total power flux measured by the sum of the CINC-indices of Great Powers in the System (multiplied by 10). Sudden changes in the power flux cannot be attributed to the war dynamics of the System, but rather to states that acquired or lost their Great Power status. This is for example the case in 1898, when the United States acquired Great Power status. Because of the short 'lead-time' of significant changes in the power flux before systemic wars, the power flux is not a useful indicator for the upcoming war dynamics of the System.



024 The current condition of the System and its future behavior can be determined by the size (development) of wars in the anarchistic System.

This study shows that the sizes of wars defined in terms of a fraction (the number of Great Powers involved a particular war divided by the total number of Great Powers in the System at the time of the war) and how the sizes of war develop over time are reliable indicators of the condition and (direction) of the development of the anarchistic System.

The size of wars is defined in terms of a fraction (it is a relative size). The sizes of wars do not develop randomly. In the figures below, I show the cumulative size distribution of wars during the 1495-2016 period and the moving averages of the sizes of five successive wars, also during the period 1495-2016.

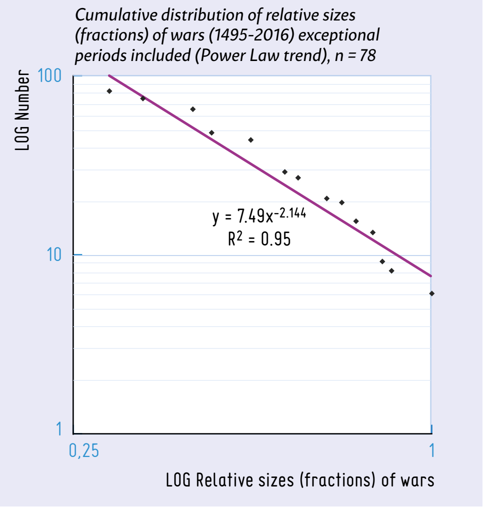
The figures below are based on Levy (38), Sarkees (52) and a number of other sources; in below table the wars during the period 1945 - August 2016 are shown (see also part IV).

War data, 1945 - August 2016 Based on Levy (nr. 115-119), Sarkees et al. (nr. 120-128), and other resources (nr. 125-134)							
No.	War	Dates	Duration (Years)	Extent (No of GP's)	Severity (in BCD)	Size (Fraction)	GP's
115	Korean War	1950-1953	3.1	4	95,4960	0.67	US, China, Fr, GB
116	Russo-Hungarian War	1956-1956	0.1	1	7,000	0.17	SU
117	Sinai War	1956-1956	0.1	2	30	0.33	GB, Fr
118	Sino-Indian War	1962-1962	0.1	1	500	0.17	China
119	Vietnam War	1965-1973	8.0	1	56,000	0.17	US
120	Sino-Vietnamese Punitive War	1979-1979	0.1	1	13,000	0.17	China
121	The Soviet Quagmire	1980-1989	9.0	1	40,000	0.17	USSR
122	Falklands War	1982-1982	0.3	1	255	0.17	GB
123	Sino-Vietnamese Border War	1987-1987	0.1	1	1,800	0.17	China
124	Gulf War	1990-1991	0.7	3	402	0.5	US, GB, Fr
125	The First Chechnya War of 1994-1996	1994-1996	2.8	1	4,000	0.17	Russia
126	Intervention in Bosnia	1995	0.1	3	27	0.5	US, GB, Fr
127	War for Kosovo	1999-1999	0,2	3	2	0.5	US, GB, Fr
128	The Second Chechnya War of 1999-2003	1999-2003	4.2	1	5,000	0.17	Russia
129	War of Afghanistan	2001-2014	13.2	4	2,955	0.67	US, GB, Fr, Germany
130	Iraq War	2003-2011	8.7	2	4,676	0.33	US, GB
131	Intervention in Libya	2011-2011	0.6	3	0	0.43	US, GB, Fr
132	War for Syria	2011-ongoing	5.5	5	20	0.71	US, GB, Fr, Iran, Russia
133	Russian-Ukraine War	2014-ongoing	2.5	1	450	0.14	Russia
134	Iranian Intervention in Iraq	2014-ongoing	2.1	1	11	0.14	Iran

Table 31 *Updated war data, 1945 - August 2016. This is an extension of the war data of Levy (38). To ensure consistency and avoid bias, I have used Levy's definitions of Great Powers,*

wars, and battle-deaths in my interpretation of the dataset presented by Sarkees et al. (52) and data from numerous sources; however, further validation of the dataset is required. Sarkees qualifies the Intervention in Bosnia in 1995 by the United States and NATO, including Great Britain and France, (War 125) as a phase in an intra-state war (The Bosnian-Serb Rebellion of 1992-1995). This intervention, also referred to as 'Operation Deliberate Force,' qualifies – I assume – as a war involving Great Powers. Sarkees classifies the 'Soviet Quagmire of 1980-1989' as an 'extra-state war.' Because this war meets Levy's requirements, I assume, I added it to the data set.
Wars 116-123 constitute the second exceptional period (1953-1989) and are shaded in grey. If the First and Second Chechnya War (respectively 1994-1996 and 1991-2003) qualify as interstate wars needs validation: These wars cause distortions in the circular trajectories in phase state. However, if excluded, this does not impact on the outcome of the assessment and predictions. The 'War of Afghanistan' (129) is arguably still ongoing, although France's involvement ended in 2012 and Great Britain's involvement ended in 2014. The Russian-Ukraine War (133) includes the annexation of Crimea by the Russian Federation (20 February - 20 March 2014) and the Russian military intervention in Ukraine (ongoing since 20 February 2014). GP: Great Powers, Fr: France, GB: Great Britain, SU: Soviet Union. The data in this table is based on Levy (38) for Wars 115-119. The data for Wars 120-128 are based on the dataset in "Resort to War 1816-2007" (52). The data for the remaining wars (127-134) were collected from: War nr. 129: "Afghanistan: Fatalities by year", icasualties.org 9 September, retrieved 14 September 2013; www.defense.gov/casualty.pdf, retrieved 29 June 2016 (through Wikipedia, retrieved 21 August 2016). War nr. 130: "Fact Sheets/Operations Factsheets/Operations in Iraq: British Fatalities", Ministry of Defence of the United Kingdom, archived from the original on 11 October 2009, retrieved 17 October 2009 (through Wikipedia, retrieved 21 August 2016). War nr. 132: "Глава Кабардино-Балкарии подтвердил гибель двадцатого российского военного в Сирии". Retrieved 12 August 2016 (through Wikipedia, retrieved 21 August 2016). War nr. 133: "Nuland Claims 400-500 Russian Soldiers Killed in Eastern Ukraine". Sputnik News. 10 March 2015. Retrieved 10 March 2015 (through Wikipedia, retrieved 21 August 2016).

Figure 29
This figure shows the cumulative distribution of relative sizes (in terms of fraction) of wars during the period 1495-2016. The size distribution can be described with a power law.



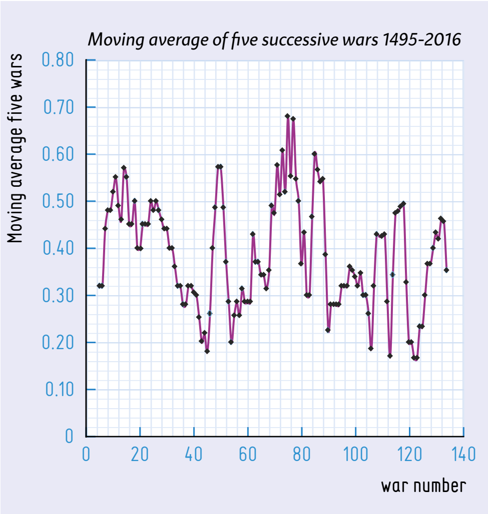


Figure 30
This figure shows the moving average of five successive wars during the period 1495-2016.

The development of the sizes of wars during relatively stable periods shows that the sizes of non-systemic wars decrease once the tipping point is reached; an effect that can be attributed to the connectivity/local stability effect.

This study shows that the size of non-systemic wars during high-connectivity regimes reaches what I call a critical size shortly before the System produces systemic wars, as occurred during the 1495-1945 period. This study shows that the range of the critical fraction is 0.17 - 0.30.

I consider the sizes of wars (in terms of proportionfraction) and their development over time to be reliable indicators of the System's condition and future behavior.

This study shows that the present international order (1945-...) reaches the critical fraction and produces a next systemic war around 2020, as I explain in more detail in part IV.

'Critical fractions' of moving averages		
International order		Critical fractions of moving averages of five successive non-systemic wars
1	1495-1618	0.18
2	1648-1792	0.30
3	1815-1914	0.19
4	1918-1939	0.17

Table 32 *This table shows the (critical) values of the moving averages of sizes of five successive non-systemic wars immediately before the System became critical during the first finite-time singularity dynamic.*

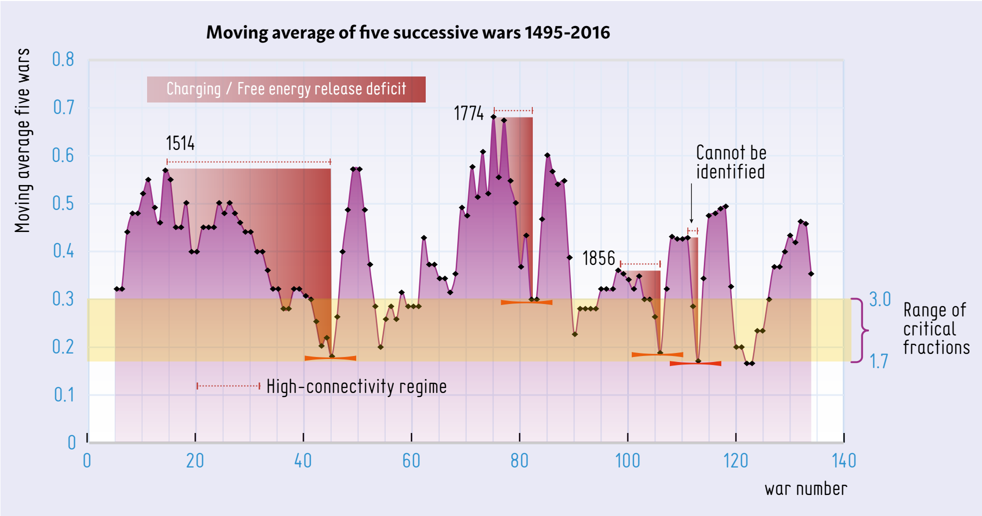


Figure 31 *In this figure the moving average of five successive wars is shown during the period 1495-2016, the numbers on the x-axis correspondent with the war numbers. In this figure the tipping points, critical fractions and the range of critical fractions are shown, as well as the buildup of free energy release deficits during high-connectivity regimes during the period 1495-1945. The sizes of free energy release deficits (depicted by triangles) are not indicative for their actual size.*

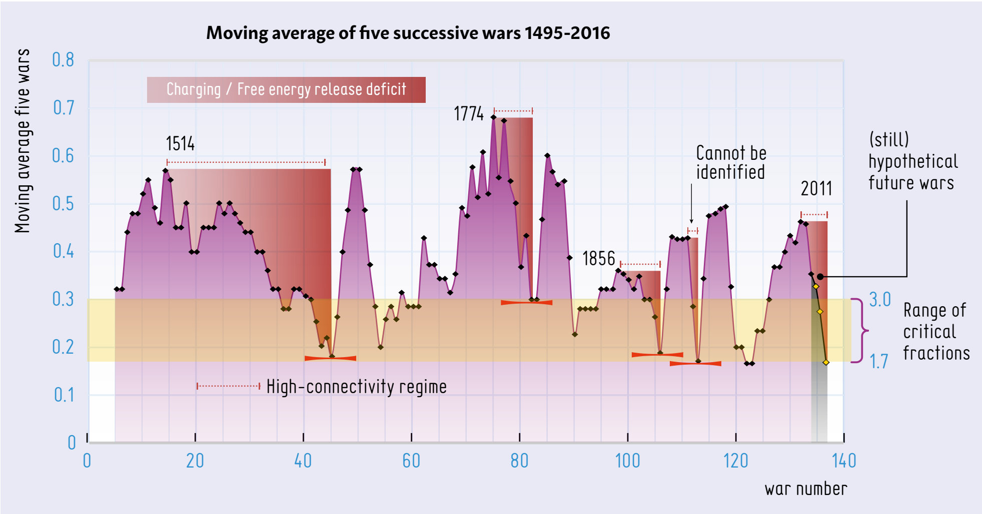


Figure 32 *This figure is an extension of figure 31: Three still hypothetical future wars with a size of one Great Power participating, are now added. This study suggests that the present order (1945-...) reached its tipping point in 2011, and is now in its high-connectivity regime and 'charging' for a next systemic war. It takes about 2-3 non-systemic wars (baseline 2014) for the current order to reach the 'critical fraction-range'. This study suggests that the System will become critical around 2020 and produce a systemic war to implement an upgraded order that allows for a lower energy state (a new relatively stable period) of the System.*

Estimates for the System to become critical following the first global order (1945-...)			
War frequency	One additional war	Two additional wars	Three additional wars
0.28 (average 1945-2016)	3.6 years (2018)	7.2 years (2021)	10.8 years (2025)
0.41 (average 1989-2016)	2.4 years (2016)	4.8 years (2019)	7.2 years (2021)

Table 33 *In this table I show how many years it could take, depending on the war frequency of the current order, to produce one, two, or three additional wars. This is a speculative calculation. The years (in the table) refer to the year the war would be produced with a baseline at 2014, the last year the System produced a non-systemic war (number 134).*

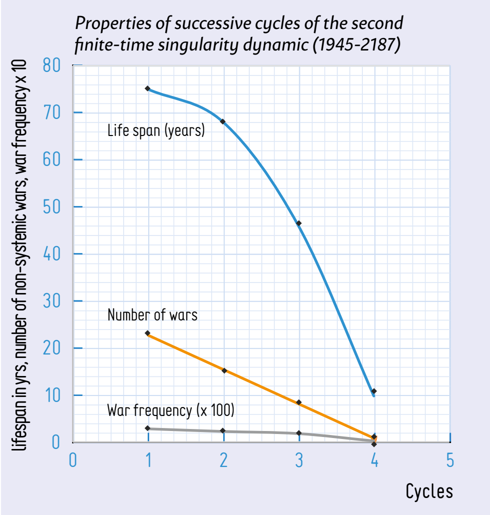
Timing of a (still) hypothetical second finite-time singularity dynamic (Based on certain properties of the 'theoretical' first finite-time singularity dynamic)			
	Start	End	Life span (years)
First global order (rel.st. per.)	1945	2020	75
Fifth systemic war	2020	2036	17
Second global order (rel.st. per.)	2036	2104	68 (factor 0.91 applied)
Sixth systemic war	2104	2119	15 (factor 0.91 applied)
Third global order (rel.st. per.)	2119	2165	46 (factor 0.67 applied)
Seventh systemic war	2165	2175	10 (factor 0.67 applied)
Fourth global order (rel.st. per.)	2175	2185	10 (factor 0.22 applied)
Eighth systemic war	2185	2187	2 (factor 0.22 applied)

Table 34 *In this table I show the timing of successive global orders and critical periods of a (still) hypothetical second finite-time singularity dynamic (1945-2187). The life spans of successive global orders and systemic wars are calculated by applying the same acceleration factor to the second, third, and fourth cycle as I determined for the undisturbed theoretical version of the first finite-time singularity dynamic. The lifespan of the first systemic war produced by the second finite-time singularity dynamic (the fifth systemic war), I calculated by applying the same ratio as applies to lifespan of the first relatively stable period (138) and lifespan of the first systemic war (30) of the first cycle of the theoretical model of the first finite-time singularity dynamic (0.22).*

Speculative calculation of the severity of systemic wars of the second finite-time singularity dynamic accompanied by four accelerating cycles (1945-2187) *(Severity = number of battle-connected deaths of military personnel, Great Powers only)*				
	Severity systemic war	Acceleration factor	Release ratio	War frequency
Cycle 1	1,971,000		0.65	0.37
Cycle 2	4,900,000	2.49	0.85	0.26
Cycle 3	8,100,000	1.65	0.93	0.17
Cycle 4	11,100,000	1.37	0.97	0.05
Cycle 5	2,330,252		0.65	0.33
Cycle 6	5,802,327	2.49	0.85	
Cycle 7	9,573,840	1.65	0.93	
Cycle 8	13,116,161	1.37	0.97	

Table 35 *This table shows the estimated severity of the systemic wars that will – the speculative model suggests – be produced by the second finite-time singularity dynamic accompanied by four accelerating cycles during the period 1945-2187. I have used the severity of successive systemic wars of the theoretical ('corrected') first finite-time singularity dynamic as a reference. I have calculated the severity of the fifth systemic war (2020-2036), by applying the release ratio to the estimated total severities of non-systemic wars during the relatively stable period of the first cycle (1945-2020). The severity of the sixth, seventh and eighth systemic war I have calculated by applying the acceleration rate (based on the theoretical model of the first finite-time singularity dynamic).*

Figure 33
Properties of successive cycles of the second finite-time singularity dynamic (1945-2187) that is constructed on the basis of the 'corrected' first finite-time singularity dynamic (1495-1945). The converging trends point to the collapse of the System around 2185.



Properties of cycles of the second finite-time singularity dynamic (1945-2187)					
	Life span	Relatively stable periods	Non-systemic wars	War frequency	Orbits
1	75		23	0.31	4.4
2	68		15	0.22	2.0
3	46		8	0.17	1.5
4	10		1	0.10	0.2

Table 36 *This table shows the 'estimated' properties of cycles of the second finite-time singularity dynamic that will also be accompanied by four accelerating cycles (1945-2187).*

Properties of the first and (hypothetical) second finite-time singularities		
	First finite-time singularity	Second finite-time singularity (hypothetical)
Life span	450 years (1945-1495)	242 years (2187-1945)
Number of cycles	4	4
Ultimate outcome	Simultaneous implementation of dedicated hierarchies in Europe and a first order with a global scale	Implementation of a non-anarchistic structure at a global scale

Table 37 *This table shows the basic properties of the first and (hypothetical) second finite-time singularities.*

025 Free will is to a great degree constrained by the deterministic nature of the System, and we are not as free as we believe (and hope).

This study shows that the System – of which we are an integral part – is to a great degree deterministic in nature; physical laws also apply to the tensions (free energy) that are produced in the anarchistic System. During the 1495-1945 period, the anarchistic System produced a self-organized, finite-time singularity dynamic accompanied by four accelerating cycles that was instrumental in its integration and expansion. A second singularity dynamic is unfolding in the (now global) System.

Wars – systemic and non-systemic – are energy releases of the System. During the 1495-1945 period, the second law of thermodynamics forced four systemic wars on the System that were necessarily produced at an accelerating rate.

The development of the first finite-time singularity dynamic (1495-1945) shows that because of its acceleration, the contingent latitude of the System progressively decreased: States had to fight increasingly 'total' systemic wars at an accelerating rate; the finite-time singularity accompanied by four accelerating cycles in fact constituted an inescapable war trap.

This study also shows that states and their populations always obey(ed) these deterministic laws without recognizing that they were doing so; the security dilemma and interacting self-fulfilling prophecies between states ensure(d) the synchronization of the dynamics of the deterministic and contingent domains of the System.

To make the implications of the nature of the System and our blind 'obedience' to the deterministic laws that apply to the System clear: all four systemic wars the anarchistic System produced would have taken place at 'exactly' the same time and with the same durations and severities, irrespective of (for example) the social issues that were at stake and the 'cast' that would play a lead role.

The systemic wars as we know them – the Thirty Years' War (1618-1648), the French Revolutionary and Napoleonic Wars (1792-1815), the First World War (1914-1918) and the Second World War (1939-1945) – are simply contingent manifestations of underlying highly deterministic systemic energy releases that could not have been avoided given the amounts of free energy the anarchistic System was producing. The versions of these wars as we know them were just one of many options: contingent dynamics and choices do not matter as long as the deterministic requirements are met.

Without the 'cast' of the Second World War (including Hitler, Stalin, Roosevelt, and Churchill) as we know it, a fourth systemic war would have occurred; the security dilemma and interacting self-fulfilling prophecies between states would have ensured the synchronization of both domains.

Our free will is much more limited than we think and hope, and the limited free will we have – determined by the contingent latitude of the System – we can and must use more wisely now with respect to self-organization, blind obedience to physical laws, and collective self-deception regarding deliberate organization and cooperation.

026 A paradigm-shift – a shift from self-organization to organization – is necessary to avoid (systemic) wars and the risk of collective self-destruction.

Until now, we were not aware of the deterministic nature of the war dynamics and development of the System. This study reveals not only the deterministic nature of the System and its dynamics but also that a deeper – and simple – order underlies our System: The 'chaotic' and 'complex' dynamics of the System are the result of physical laws the System obeys.

It is fair to say that 'history', historical research methods and international relations theory lack organizing principles and a scientific framework. Until now, these 'sciences' were concerned only with contingent dynamics and were unaware of the existence and impact of an underlying highly deterministic domain. The regularities and mechanisms I expose in this study are only the first step: there is much (more) to discover, to understand, and to improve with respect to the framework presented herein.

This study makes it possible to develop effective strategies to prevent war and to design international orders that can avoid war – at least in theory.

This study shows that wars can be considered energy releases that are 'governed' by physical laws (and by the second law of thermodynamics, in particular).

This study also shows that the System produced (and still produces) free energy because of the intrinsic incompatibility between the (increasing) connectivity and security in anarchistic systems. Free energy production can be 'stopped' (or reduced) by decreasing the System's connectivity (growth) or by 'abolishing' its anarchistic nature.

1 **Avoiding connectivity growth**.
The connectivity growth of the System is (mainly) a function of population growth, although it is also a function of increasing life expectancies and standards of wealth. Avoiding population growth is not a realistic prevention strategy.

2 **Abolishing anarchy**.
This study shows that until now, the successive upgrades of orders in the anarchistic System, which eventually led to the implementation of two dedicated, non-anarchistic hierarchies in the core of the System (Europe), was able to be accomplished only by means of systemic war.

The state (its structure, its functions), (successive) international orders, international relations theories, ideologies and military doctrines reflect the anarchistic nature of the System. States are designed to fight wars. The (urgent) question now has become: Is it realistic to expect that Great Powers – states in the current order – can implement an upgraded order (implying a fundamental reorganization of the United Nations, for example) without systemic war, also taking into consideration that at this point, the System is in its high-connectivity regime of the first cycle of the second singularity dynamic (1945-...) and that issues and tensions are not (cannot) be resolved but are 'stored' in the System instead? Although the prospects of controlling the momentum of the anarchistic System toward criticality (systemic war) is a challenge, no time or effort should be lost to fundamentally change the nature of the System and its dynamics: we now (better) understand how the System works and develops and how it deceives us.

Whereas architects cannot design and construct safe buildings without a thorough understanding and 'application' of the law of gravity, politicians and social scientists cannot understand the workings of the System or design and construct safe international orders that do not collapse or that can be rebuilt only by means of systemic war, without understanding the deterministic nature of the System. There is no time to lose.

PART II

PERSPECTIVES

History is a vast early warning system

Norman Cousins

Introduction

In this part I discuss fifteen different 'perspectives' of the System; each perspective focuses on specific aspects and properties of the System. This multi-perspective approach makes it possible to acquire new insights in the exact workings of the System, and to determine relationships between properties.

I discuss the following perspectives:

1. ***The System depicted as an input-throughput-output model***
2. ***The System (1495-1945) depicted as a finite-time singularity accompanied by four accelerating cycles***
3. ***The System depicted as a coherent 'set' of closely related and optimized dynamics that made up the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945)***
4. ***The System depicted as an undistorted finite-time singularity dynamic***
5. ***The System depicted as a binary network of war switches***
6. ***The System depicted as a slowly-driven, interaction-dominated threshold system***
7. ***The System depicted as a dynamical system***
8. ***The System depicted as a path-dependent dynamic***
9. ***The System depicted as a sequence of dynamics with particular characteristics***
10. ***The System depicted as energy transfers***
11. ***The System depicted as an interacting system of a deterministic and contingent domains, and accompanying variables***
12. ***The dynamic System depicted as a change model***
13. ***The finite-time singularity depicted as a distinct phase in a long-term process of social integration and expansion (SIE)***
14. ***The first international order of the System depicted as a damped oscillator***
15. ***The System depicted as a set of early warning signals***

Each chapter has a similar structure: First I show a schematic representation of the aspects and properties the perspective focuses on, followed by an explanation and discussion of the perspective.

1 The System depicted as an input-throughput-output model

1.1 Schematic representation of the System as an input-throughput-output model

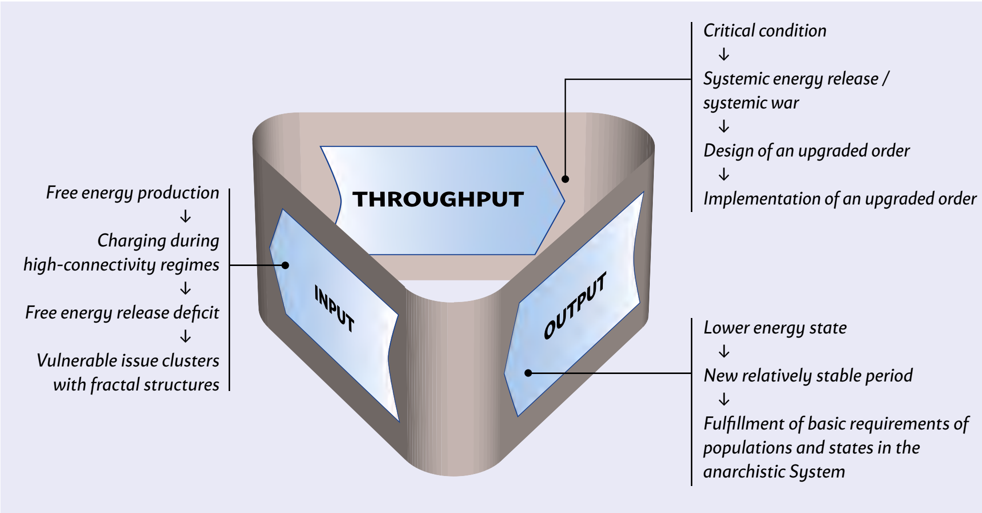


Figure 34 *This figure depicts the System as an input-throughput-output model of the anarchistic System.*

1.2 Explanation of the model

The System can be depicted as an input-throughput-output model that transforms free energy in the form of tensions into new upgraded international orders in the contingent domain of the System.

1) *Input*. Free energy is the input of the System. The free energy has its origin in the intrinsic incompatibility between increasing connectivity and security in anarchistic systems. In the contingent domain, free energy is manifested as tensions. Increasing connectivity results in increasing interdependence of states, among other things for their mutual security. Security is a basic requirement of states and is essential for their survival.

Incompatibility between connectivity and security produces increasing numbers of security issues, and accompanying tensions and hostilities. A security dilemma that acts as a positive feedback mechanism is inherent to anarchistic systems; it further fuels tensions and hostilities in the System. These issues and tensions also produce alliance dynamics, characterized by efforts of states to ensure their security by forming alliances with other states. The issues and tensions can be transformed into destructive energy.

2) *Throughput*. The free energy the System produces crystalizes into vulnerable issue clusters. Vulnerable issue clusters are networks of states and issues that are just one step from being activated; activation results in war.

Depending on the connectivity of the vulnerable issue network and on the thresholds states use to make war decisions ('war' or 'no war'), the System reaches a percolation condition, becomes critical, and is highly susceptible to perturbations that can be communicated system-wide. System-wide communication, coordination, and planning are enabled through a correlation length of one that spans the System at criticality.

Given the condition of the System, a trigger, for example, a small incident, then unavoidably activates an issue, causing a local war. The percolation and critical condition of the System, however, ensure that this initially local war sets in motion a domino effect, causing a system-wide systemic war.

Because the correlation length of the System at criticality is one and spans the System, systemic wars are system-wide, and allow for the system-wide 'coordinated' destruction of issues and tensions, and for the design and implementation of a new system-wide order. The new order that emerges from a systemic war produces a new relatively stable period that enables further growth of the connectivity of the System.

Through systemic wars, free energy is put to work, in accordance with the principle of 'least free energy' - the second law of thermodynamics - resulting in a new order that enables a lower energy state of the System.

Four cycles can be distinguished in the war dynamics of the System. Each cycle consists of a relatively stable period followed by a systemic war. Over time, the incompatibility between the increasing connectivity of the System and security intensified. The increasing incompatibility, in combination with an increasing pace of life in the System that also impacts the speed at which tensions spread, caused the frequency of cycles to accelerate, and the severity of systemic wars to grow at an increasing rate. The increasing pace of life is also attributable to the increasing connectivity of the System.

3) *Output*. The output in Europe, the core of the System consisted of three successive orders that could still bridge the intrinsic tensions between increasing connectivity and anarchy.

Cycles, relatively stable periods and critical periods produced by the anarchistic System through the first finite-time singularity dynamic (1495-1945)				
Cycle	Period	International order / Relatively stable period	Critical period / Systemic war	Name of systemic war
1	1495-1648	1495-1618	1618-1648	Thirty Years' War
2	1648-1815	1648-1792	1792-1815	French Revolutionary and Napoleonic Wars
3	1815-1914	1815-1914	1914-1918	The First World War
4	1918-1945	1918-1939	1939-1945	The Second World War

Table 38 *This table specifies successive cycles, relatively stable periods (international orders) and critical periods (systemic wars) the anarchistic System produced by means of the first finite-time singularity dynamic (1495-1945).*

The fourth systemic war (1939-1945), however, could not produce a viable order in an anarchistic setting, given the level of connectivity and interdependence the System had reached. In 1939, the System reached the critical connectivity threshold (the singularity in finite time); the incompatibility of increasing connectivity and security reached infinite levels, resulting in the production of infinite levels of free energy restricted only by so-called 'finite-size effects,' and causing a collapse of the no longer viable anarchistic System. To ensure compliance with the second law of thermodynamics and the survival of states, the System produced a phase transition, allowing for the implementation of a fundamentally different non-anarchistic System. The second law of thermodynamics 'forced' the System to implement two dedicated hierarchies in the core of the System (Europe).

The fourth systemic war (the Second World War, 1939-1945) constituted the phase transition. Two dedicated hierarchies were initially implemented in Europe, the core of the System: A Western hierarchy controlled by the United States, and an Eastern hierarchy controlled by the Soviet Union. In 1989 when the Eastern hierarchy collapsed, the Western hierarchy absorbed components (eastern European states) of the Eastern hierarchy.

Through the implementation of two dedicated hierarchies, with the Western hierarchy based on democratic and capitalistic organizing principles and the Eastern hierarchy based on an authoritative and centralized economic principles of direct allocation, anarchy was neutralized within these respective hierarchies, and the incompatibility between increasing connectivity and security resolved, stopping the production of free energy within these hierarchies. The (initial) net-result was a decrease in the production of free energy in the System; however, this only was a temporary respite, until the rivalries between the United states and the Soviet Union – and the respective hierarchies they controlled – led to the production of large amounts of tensions (free energy).

Although, the finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period was above all a European dynamic, the singularity dynamic – the System during the 1495-1945 period – also produced two other related outputs with a (ultimately) global reach: expansion of the System outside Europe, and the implementation of the first global international order (at a global scale of the System). The process of integration in Europe (the implementation of upgraded orders through four accelerating cycles) was accompanied by a process of expansion outside Europe (outside the core of the System); integration of the core of the System (Europe) and expansion of the core outside Europe were coevolving and mutually reinforcing dynamics. Because of the coevolving nature of the process of integration and expansion of the System – both 'powered' by the finite-time singularity accompanied by four accelerating cycles (1495-1945) – the ultimate phase transition through the fourth systemic war (The Second World War, 1939-1945) also had an 'external' dimension, and in fact constituted a 'dual' phase transition: At the same time as two dedicated hierarchies were implemented in Europe (the core of the System), the first global international order was established at a global scale of the System.

2 The System (1495-1945) depicted as a finite-time singularity accompanied by four accelerating cycles

2.1 Schematic representation of the System as a finite-time singularity accompanied by four accelerating cycles

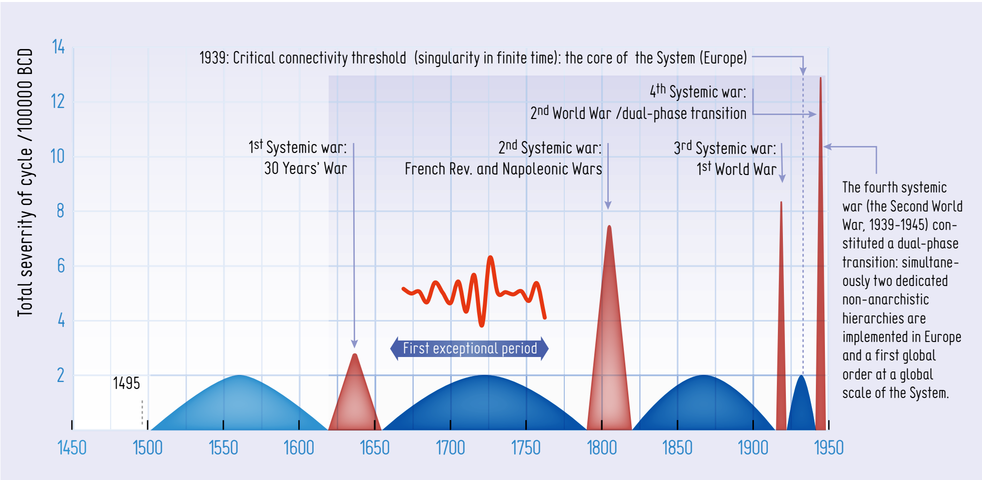


Figure 35 *This figure shows the first finite-time singularity accompanied by four accelerating cycles (1495-1945), ultimately resulting in a phase transition (through the fourth systemic war: The Second World War, 1939-1945) when in 1939 the anarchistic System reached the critical connectivity threshold. The phase transition had two related effects: The implementation of dedicated non-anarchistic hierarchies in Europe (the core of the System), and the implementation of the first global international order at a global scale of the System. In the figure the blue pyramids depict the total severity of wars during successive cycles (in BCD). The time scale (x-axis) and severities (y-axis) are shown to scale.*

2.2 Explanation of the perspective

The dynamics of the System during the 1495-1945 period qualify as a finite-time singularity accompanied by four accelerating cycles that, in 1939, reached the critical connectivity threshold and produced a phase transition resulting in (1) the initial implementation of two dedicated hierarchies in Europe, that merged into one hierarchy in 1989, and (2) the establishment of the first global international order.

It is possible to distinguish four components in the finite-time singularity dynamic that unfolded in the System during the 1495-1945 period:

1 ***Free energy – tensions – that powered the singularity dynamic***

The singularity dynamic was initiated by a combination of factors and conditions; at its core is the incompatibility between increasing connectivity (interdependence of states) and security in anarchistic systems. The incompatibility between increasing connectivity and security requirements resulted in the production of free energy in the System that manifested itself in tensions and hostilities, the build-up of destructive potential in the form of armies, navies, etc. and in alliance dynamics.

The System obeys physical laws. In this respect, three principles related to the second law of thermodynamics are especially relevant, and determined and shaped the dynamics of the System: (1) the principle that 'free energy will be put to work', (2) the principle of 'least free energy', implying that the System will introduce a 'new' order by applying free energy that enables a lower free energy state of the system, and (3) the principle that free energy follows a path of least resistance.

The System put free energy (tensions) to work through systemic wars, and, consistent with the second law of thermodynamics, this free energy produced upgraded orders to achieve a lower free energy state in the System. However, because of the intrinsic incompatibility between connectivity and security, that was not resolved through the implementation of upgraded orders, it was just a matter of time before the anarchistic System again produced free energy (tensions), eventually reached a critical condition and produced another systemic war.

2 *Cycles*

Each of the four cycles that constitute the singularity dynamic had a similar life cycle.

Typically, a relatively stable period was followed by a systemic war. During relatively stable periods, states grew, developed, and ensured the fulfillment of their basic requirements. Population growth and the growing need for the fulfillment of basic requirements of individuals, social systems, and states, and the increasing rivalry between states following differentiated growth paths, unavoidably issues in the anarchistic System. These issues produced tensions, hostilities, and the build-up of destructive energy and alliance dynamics.

The intrinsic incompatibility between connectivity and security was the engine of the singularity dynamic, and reflects a competition between order and disorder in the System; this competition resulted in cyclic dynamics.

Given the increase in connectivity of the System and the production of free energy this implies, the second law of thermodynamics periodically forced the System through systemic wars to implement upgrade orders to allow for a lower energy state of the System.

During relatively stable periods (international orders) certain 'forces' tried to prevent change (the implementation of upgraded orders); by doing so these forces contributed to the structural stability of the international order, but also to its (increasing) level of disorder and eventual collapse.

The origin of forces that tried to maintain the status quo can be explained by the nature and dynamics of the anarchistic System in which populations and states must fulfill basic requirements to survive, and over time became increasingly dependent on other states to achieve this. During systemic wars, dominant states ensured that the upgraded order were to be implemented promoted their specific interests in the anarchistic System. Because of these privileges these dominant states also ensured that the international orders they implemented included arrangements that supported the status quo and restrained potential rival states, that could (eventually) become a threat to them and the structural stability of international order. However, at a certain point the forces that tried to prevent change – including efforts of dominant states – were insufficient; the build-up of tensions could not be stopped and their effects no longer contained. A tipping point during the life cycle of relatively stable periods (international systems) contributed to the System becoming critical and producing a systemic war as a consequence.

As explained – as a consequence of the increasing connectivity of the System – the System produced increasing amounts of tensions (free energy). During the life cycle of relatively stable periods (international orders) these tensions were periodically released through non-systemic wars, but were also – when not released or releasable – stored in the System, and then crystallized in underlying vulnerable issue clusters. The connectivity of these issue clusters also impacted on the non-systemic war dynamics of the System.

The connectivity of these clusters, in combination with the threshold levels of states regarding war decisions, determined the size and frequency of the non-systemic wars the System produced during the relatively stable periods.

Following a systemic war, the connectivity of these clusters was initially relatively low, as was the size of non-systemic wars that were periodically triggered. During the low-connectivity regime of relatively stable periods, the connectivity of the System determined the size of non-systemic wars: increasing connectivity implied an increasing size of non-systemic wars. However, at a certain point during the life cycle of relatively stable periods, a tipping point was reached and increasing connectivity resulted in local stability that started limiting the sizes of the non-systemic wars; when the tipping point was reached the System was in a high-connectivity regime until the next systemic war.

Non-systemic, as well as systemic, wars can be considered energy releases for the System. The increasing connectivity of the underlying network of vulnerable issue clusters, in combination with the increasing inability of the System during high-connectivity regimes to periodically release free energy through non-systemic wars, primed the System for massive releases of free energy through systemic wars.

Systemic wars, contrary to non-systemic wars, are not local, and are manifestations of criticality. Criticality implies that the System reaches a correlation length of one, enabling system-wide communication, coordination, and planning. These particular conditions allowed both for the coordinated destruction of issues and tensions by employing destructive free energy, and for the collective design and implementation of new upgraded international orders that ensure at least temporary structural stability before free energy is again produced.

3 ***Accelerating dynamics (cycles)***

Increasing connectivity had a multitude of effects, including an increase in the pace of life of the System. The increasing pace of life of the System also increased the speed of spreading phenomena, including the spreading of tensions and hostilities in the System. Increasing connectivity also implied increasing growth rates of destructive free energy that built up in the System during the 1495-1945 period, and that had to be put to work (through systemic wars) at an accelerating pace, to ensure compliance with the second law of thermodynamics.

4 ***A singularity in finite-time; the critical connectivity threshold of the System***

The singularity in finite time is a result of the unsustainable accelerating growth rate of free energy and tensions in the anarchistic System.

Before the System in 1939 reached the critical connectivity threshold – the singularity in finite time – and collapsed as a consequence, the System was three times able (through the three preceding systemic wars) to implement upgraded orders within the anarchistic System; the lower levels of connectivity of the anarchistic System then still allowed the System to find viable orders within an anarchistic context, that ensured compliance with the second law of thermodynamics.

However, when the critical connectivity threshold was reached in 1939, the System produced infinite amounts of free energy (tensions) and could no longer find a viable new order within the anarchistic context; now the context had to be changed. This fundamental change was accomplished through a phase transition. Two dedicated hierarchies were initially introduced, and within these two hierarchies, anarchy and the production of free energy were neutralized; this temporarily reduced the net-amount of free energy the (now) global System produced.

The effects of the singularity dynamic situated in Europe were not limited to Europe itself; the singularity dynamic also initiated a process of expansion of European states to regions outside Europe, and contributed to the establishment of the first global international order.

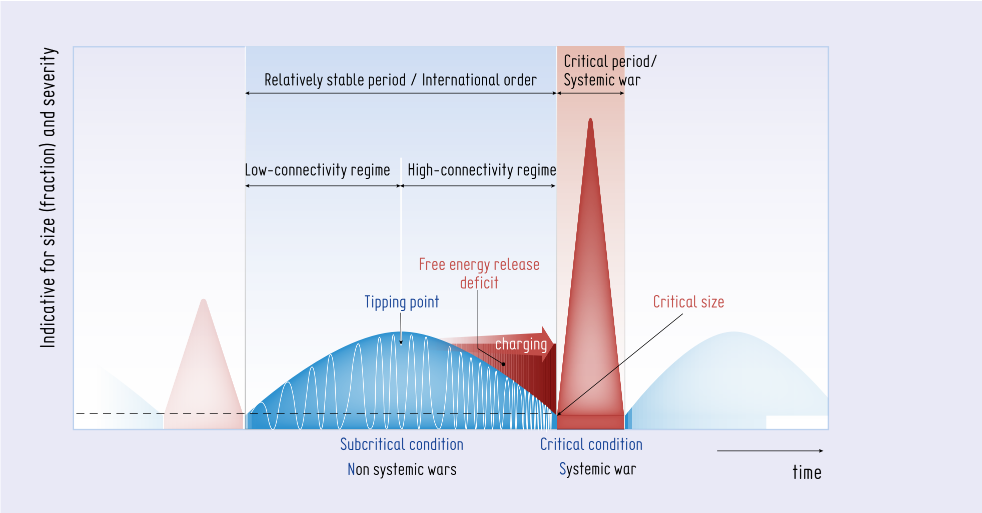


Figure 36 *This figure shows a schematic representation of a typical cycle. The finite-time singularity dynamic that developed and unfolded in the System during the period 1495-1945, was accompanied by four accelerating cycles. Cycles have similar life cycles. This study suggests that the System is presently in the high-connectivity regime of the first cycle of the second finite-time singularity dynamic (19454-…), and is 'charging', and storing free energy (unresolved issues and tensions) that crystalize in vulnerable issue clusters. The moment the clusters percolate the System, the System will become critical and produce a systemic war.*

Direct and indirect connectivity effects	
Effect	Explanation
Increasing incompatibility of the System.	Connectivity and security are intrinsically incompatible in anarchistic systems. Incompatibility produces the tensions and free energy that power the singularity dynamic.
Emergence of a tipping point in the non-systemic war dynamics during relatively stable periods of cycles, marking a switch from a low- to high-connectivity regime.	During relatively stable periods the connectivity of the System increases. The connectivity of the System determines the size and frequency of non-systemic wars the System produces. When the System reaches the tipping point of relatively stable periods states become more stable because of (what I name) the connectivity/stability-effect; from that point onwards, until the System becomes critical, the size of non-systemic wars the System can produce decreases. This effect primes the System for systemic war.
Increasing pace of life.	Population size determines the pace of life of the System. An increase in the pace of life also implies in increase in the speed of spreading phenomena, including the spreading speed of tensions and hostilities in the System.

Direct and indirect connectivity effects	
Increasing robustness and fragility.	Increasing connectivity of the System implies increased robustness and increased ability to absorb perturbations without producing non-systemic wars. Increasing robustness implies that the System's ability to produce free energy-release events (non-systemic wars) becomes increasingly limited/restrained. At the same time as the System's robustness increases, the fragility of the System (the ability of the System to maintain itself in a stability domain) decreases; robustness and fragility of the System are two sides of the same coin.
Increasing structural stability.	Connectivity increase also contributes to the structural stability of the System; its organizational stability (permanence) as well as the permanence (stability) of state-structures (form and size) in the System.
Increasing energy requirements of systemic wars to accomplish a rebalancing of the System through the implementation of upgraded orders.	Increased connectivity of the System impacts the energy required to rebalance the increasingly stable System.
Increasing interdependence.	Connectivity growth and growth of interdependence go hand-in-hand. Increasing interdependence has positive and negative effects in an anarchistic System. Positive: it improves the ability of states to fulfill certain basic requirements. Negative: it unavoidably produces issues and tensions that negatively affect the security of states, but also identities of humans and social systems.
Increasing alliance dynamics.	Increasing connectivity results in (more) issues and tensions in the System; in response states try to hedge certain risks by forming alliances.

Table 39 *This table shows and explains the most obvious connectivity effects.*

3 The System depicted as a coherent 'set' of closely related and optimized dynamics that made up the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945)

3.1 Schematic representation of the coherent set of closely related and optimized dynamics, that made up the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945)

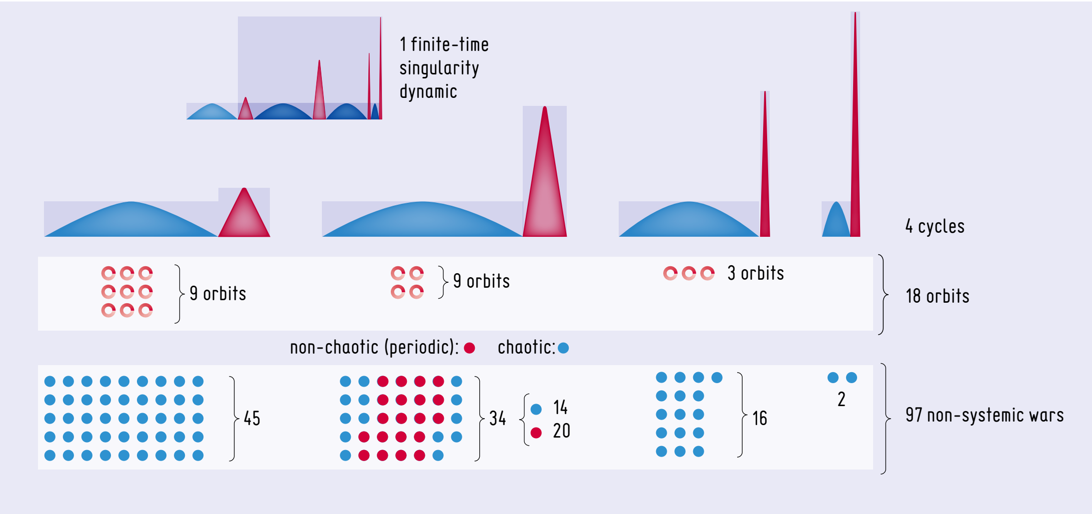


Figure 37 *This figure schematically shows the four 'levels' of dynamics that can be distinguished in the System during the period 1495-1945.*

3.2 Explanation of the model

It is possible to distinguish between four levels of 'dynamics' that together formed the highly optimized finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period.

The basic building blocks – level four dynamics – of the other three dynamics (levels) are non-systemic wars. During the 1495-1945 period, the anarchistic System produced 97 non-systemic wars; expansion wars excluded.

A closer look at the non-systemic war dynamics of the System reveals, that non-systemic wars 'normally' (when the System was regulated by at least three degrees of freedom and produced chaotic non-systemic war dynamics as a consequence) grouped in 'orbits' in phase state. Each orbit consists of a number of non-systemic wars, that produce circular trajectories in phase state (defined by the size and intensity of non-systemic wars). Each orbit can be defined by the average size of the non-systemic wars that make up respective orbits.

During the life span of the second cycle (1648-1815) the non-systemic wars were temporarily distorted, and non-chaotic in nature. This period I name the first exceptional period (1657-1763). During this period the System did not produce 'orbits', but periodic war dynamics instead. I determined that the System would have produced 18 orbits, if its dynamics would not have been distorted during the exceptional period (1657-1763).

During the life span of the finite-time singularity dynamic (1495-1945), the System also produced four accelerating cycles; each cycle consisting of a relatively stable period, followed by a systemic war. It is no coincidence that the life spans of successive relatively stable periods and the respective systemic wars, accelerated with the same rate (except for the fourth systemic war, the Second World War, 1939-1945, which had a longer life span because it included besides a European 'component', also a global component, as I explain in this study).

Consistency of dynamics of the System (1495-1945) Calculations based on data from Levy (38)			
Level	Dynamic	Number of occurrences	Remarks
1	Finite-time singularity	1	
2	Cycle	4	Accelerating
3	Orbit	18	Number determined through interpolation.
4	Non-systemic wars	97	During successive relatively stable periods (international orders) the System produced respectively: 45 - 34 - 16 - 2 non-systemic wars; expansion wars excluded.

Table 40 *This table shows the number of occurrences of four types of dynamics in the System during the 1495-1945 period.*

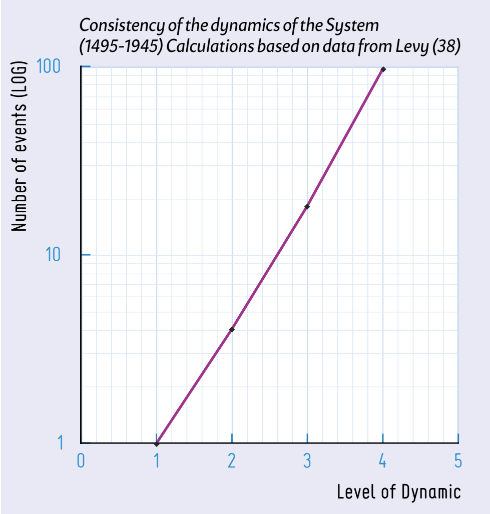
Occurrences of dynamics per cycle (1495-1945) Calculations based on data from Levy (38)					
Type	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Total
Non-systemic wars (level 4)	45	34	16	2	97
Orbits (level 3)	9	6 (Est. through interpolation)	3	0	18
Cycles (level 3)	1	1	1	1	4
Finite-time singularity dynamic (level 1)					1

Table 41 *Specification of dynamics of cycles of the first finite-time singularity dynamic (1495-1945).*

Above tables shows the different levels – dynamics – that can be distinguished. These levels form the components (building blocks) of the finite-time singularity, accompanied by four accelerating cycles, consisting of 97 non-systemic wars, that grouped in 18 orbits (if the non-systemic war dynamics would not have been temporarily distorted during the first exceptional period (1657-1763)).

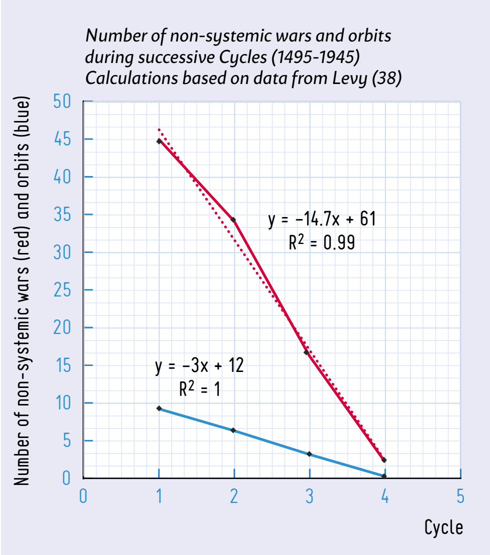
The numbers 1 - 4 - 18 - 97, respectively the number of singularity dynamics (1), cycles (4), orbits (18), and non-systemic wars (97), qualify as a Zipfian distribution.

Figure 38
This figure shows the number of non-systemic wars (97, nine expansion wars excluded), orbits (18) and cycles (4), that constituted the first finite-time singularity (1495-1945). The number of occurrences of respective dynamics qualify as a Zipfian distribution.



However, the Zipfian distribution of the appearances of the respective dynamics is not the only remarkable regularity; the number of non-systemic wars during successive cycles – as well as the number of orbits they grouped into (assuming no distortion during the second cycle) – both decreased linearly.

Figure 39
This figure shows the number of non-systemic wars (in red, expansion wars excluded, 45 - 34 - 16 - 2) and the number of orbits (in blue, 9 - 6 - 3 - 0, number of orbits of the second cycle based on interpolation) the anarchistic System produced during successive cycles of the first finite-time singularity dynamic (1495-1945). I argue that the System would have produced six orbits during the second cycle if the System's non-systemic war dynamics would not have been disturbed during the first exceptional period (1657-1763). The number of orbits of the first, third and fourth cycle (respectively: nine, three and zero) is based on empirical data. The number for the third cycle (six) is determined by interpolation.



Furthermore, the number of occurrences during cycles at each level of dynamics also developed very regularly; they can be consistently described by a second degree polynomial ($y = a\,x^2 + bx + c$), when x is the type of dynamic, and y the number of occurrences at respective levels.

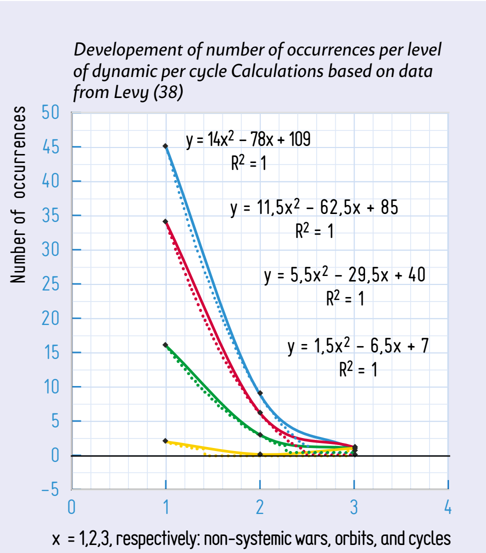


Figure 40
This figure shows the number of occurrences per type of dynamic (non-systemic wars, orbits and cycles) per cycle; the first cycle in blue, etc.
In each case – in case of each cycle – the development of the number of occurrences can be described by a second degree polynomial, with in all cases $R^2 = 1$.

Below figure gives an overview of regularities, and their mathematical equations.

Overview of regularities, and their mathematical equations. Data Levy (38)			
Dynamic	Equation (y = number of occurrences)	R^2	Type
First finite-time singularity dynamic (1495-1945)		1.00	Zipfian distribution
Orbits	$y = -3x + 12$ (x = cycle number)	1.00	Linear
Non-systemic wars	$y = -14.7x + 61$ (x = cycle number)	0.99	Linear
Cycle 1 (1495-1648)	$y = 14x^2 - 78x + 109$ (x = type of dynamic, x=1 is no. of non-systemic wars)	1.00	Second degree polynomial
Cycle 2 (1648-1815)	$y = 11.5x^2 - 62.5x + 85$ (x = type of dynamic, x=1 is no. of non-systemic wars)	1.00	Second degree polynomial
Cycle 3 (1815-1918)	$y = 5.5x^2 - 29.5x + 40$ (x = type of dynamic, x=1 is no. of non-systemic wars)	1.00	Second degree polynomial
Cycle 4 (1918-1945)	$y = 1.5x^2 - 6.5x + 7$ (x = type of dynamic, x=1 is no. of non-systemic wars)	1.00	Second degree polynomial

Table 42 *Overview of regularities, and their mathematical equations.*

The various dynamics in the System are powered by the free energy (tensions) the anarchistic System produced; the production of free energy (tensions) in the System was (and still is) a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems. The second law of thermodynamics applies to the free energy (and the dynamics) the anarchistic System produced (and still produces).

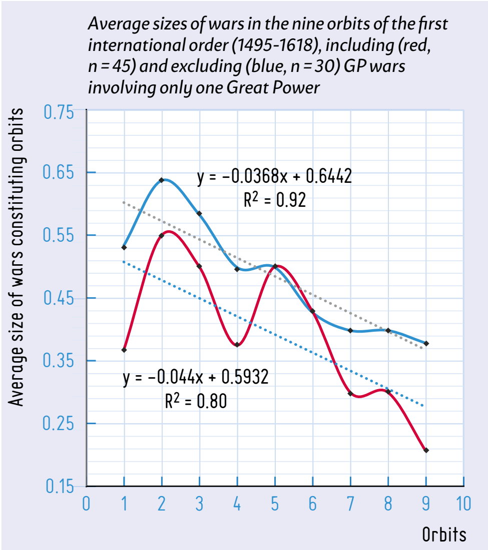
The four types of dynamics I identified fulfill certain functions for the System, and comply with the 'demands' of the second law of thermodynamics.

Through non-systemic wars (the fourth level of dynamics), the System released 'local' tensions in the System, that concerned a limited number of states, and specific issues they 'shared'.

These 'separate' non-systemic wars, however, grouped in orbits (clusters); with specific properties, further analysis shows. The size development of successive orbits (defined by the average size of non-systemic wars making up respective orbits), reveals their function for the System.

During the first cycle (1495-1648) the System produced 45 non-systemic wars, that 'grouped' in nine orbits.

Figure 41
This figure shows the properties of the nine orbits the anarchistic System produced during the first relatively stable period (the first international order, 1495-1618). The properties developed very regularly: The orbits – the war dynamics during the first international order – constitute a damped oscillator. In the red plot Great Power wars with one Great Power are included (n = 45); in blue Great Power wars only involving one Great Power are excluded (n = 30).



As above figure shows, the sizes of these orbits (the average sizes of non-systemic wars, making up these nine orbits), constitute a damped oscillator: non-systemic wars making up orbits can be considered efforts of the System to re-establish a certain balance – equilibrium – during the first relatively stable period (in this particular case). Because these corrective actions (orbits) were implemented with a delay, they caused over- and undershoots (oscillations). The damping of these oscillations, I contribute to the connectivity/local stability effect, that increasingly impacted on the sizes of successive non-systemic wars, during the life span of the first relatively stable period. When the oscillations eventually faded out – became completely damped – the System became critical, and produced a systemic war (the Thirty Years' War, 1618-1648).

The second level of dynamics – cycles – are a direct response to 'demands' of the second law of thermodynamics. During relatively stable periods, the System produced (and still produces) accelerated amounts of free energy (tensions). Because of the connectivity/local stability effect, at a certain point during the life span of a cycle, these tensions could not be released any longer through non-systemic wars, and instead of being released, these tensions were 'stored' in the System, formed a 'free energy release deficit', and crystallized in underlying vulnerable issue clusters with fractal structures, that eventually percolated the System, and caused it to become critical and produce a systemic war.

Through systemic wars – consistent with the second law of thermodynamics – the System put free energy (tensions) to work, to implement upgraded orders that allowed for a lower energy state (a 'new' relatively stable period) of the System. This dynamic ensured that the performance of the System (the fulfillment of basic requirements of uneven states in the System) was maintained.

However, because of the increasing connectivity of the System, the System (still) produced accelerating amounts of free energy (tensions), that eventually (at an accelerating rate) had to be put to work, to ensure compliance with the second law of thermodynamics. The increasing connectivity of the System, however, not only resulted in the production of accelerating amounts of free energy (tensions), but also in an acceleration of the System's intrinsic dynamics, including the frequency of successive cycles (systemic wars).

This accelerating dynamic could however not be sustained, and when the anarchistic System in 1939 reached the critical connectivity threshold, the anarchistic System produced 'infinite 'amounts of free energy (tensions) and collapsed as a consequence. In response, the System produced a dual-phase transition (1939-1945, the fourth systemic war, the Second World War). Through this dual-phase transition, the System simultaneously implemented two dedicated non-anarchistic hierarchies in the core of the System (Europe), and the first global order at a global scale of the System.

Functions of dynamics – components – of the anarchistic System (1495-1945)

Level	Dynamic	Number of appearances	Function
1	Finite-time singularity dynamic	1	Ensure performance and evolvability of the System; balance criticality and subcriticality of the System
2	Cycle	4	Balance – optimize – order and disorder during the life span of cycles
3	Orbit	18	Re-establish equilibrium during relatively stable periods
4	Non-systemic war	97	Release local tensions

Table 43 *This table shows the functions of the four 'types' of dynamics that can be distinguished in the System during the period 1495-1945.*

4 The System depicted as an undistorted finite-time singularity dynamic

4.1 Schematic representation of the undistorted finite-time singularity dynamic

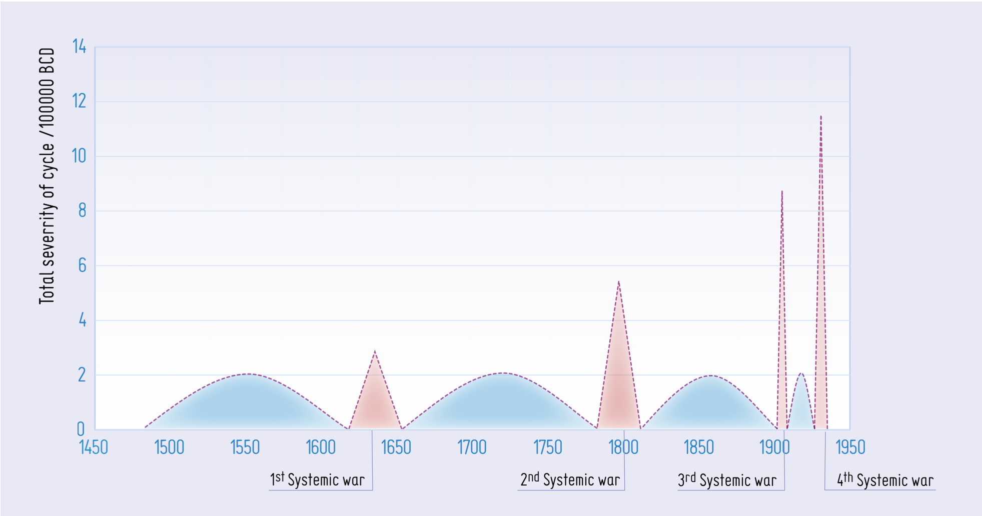


Figure 42 *This figure shows the undistorted finite-time singularity that can be constructed when a number of 'corrections' is applied based on the insights provided by this study.*

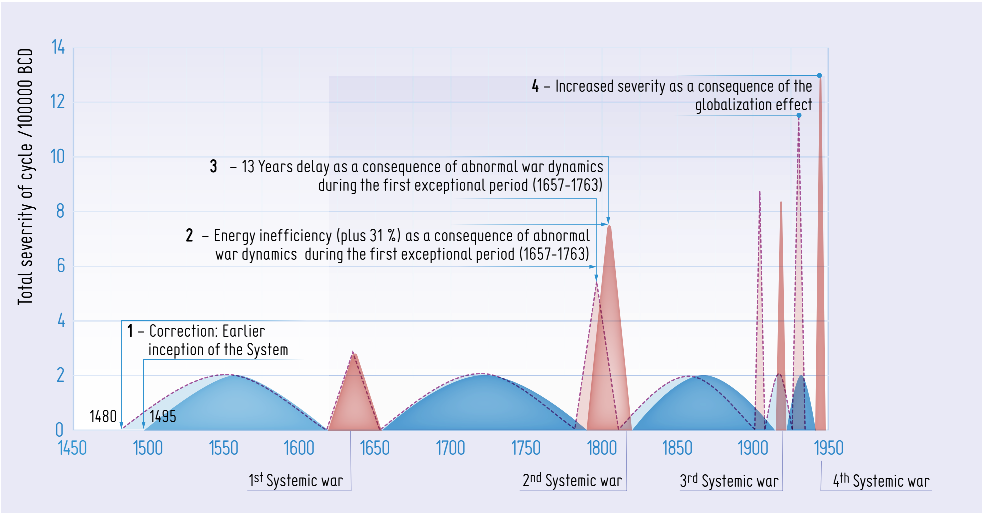


Figure 43 *This figure shows both the actual and undisturbed singularity dynamics: the differences – 'distortions' discussed in this study – are visible and explained.*

4.2 Explanation of the model

In this chapter I discuss an undistorted – theoretical – version of the finite-time singularity dynamic accompanied by four accelerating cycles, the System produced during the 1495-1945 period.

Such an 'undistorted' model can be constructed as follows:

1) By applying mathematical equations that describe the dynamics and development of the actual finite-time singularity dynamic, including the frequency of cycles and the accelerating growth of the severities of successive systemic wars.

2) By correcting distortions in the actual finite-time singularity dynamic, including a misinterpretation of data by historians.

3) By 'finite-tuning' certain parameters and properties of the singularity dynamic, assuming consistency between correlation coefficients.

This is an iterative process.

The theoretical singularity dynamic can be used to analyze the performance of the actual singularity dynamic (as it unfolded), and can shed light on some of the assumptions made in this study. A theoretical model of the first finite-time singularity dynamic (1495-1945) can also be of help as a framework for reference in assessing the condition of the current global System and of the second singularity dynamic the System is now producing.

4.3 Corrections

The finite-time singularity the System produced during the 1495-1945 period was distorted for a number of reasons; in the theoretical model these distortions are 'corrected'. The distortions and corrections include:

1 *Misinterpretation of data and of historical events that established the start date of the System*

The start time of the System was not 1495 but 1480, as I explain in statement 152 This distortion can be attributed to a misinterpretation of historic events. This correction also means that six non-systemic wars should be included in the first relatively stable period (international order). This also implies that the sum of the severities of non-systemic wars during this relatively stable period should be corrected upwards.

2 *Abnormal war dynamics during the first exceptional period (1657-1763) that caused a delay in the System's development and 'energy inefficiencies'*

During the life span of the second relatively stable period (1648-1792), non-systemic war dynamics were temporarily distorted (1657-1763); they were periodic and 'hyper-excited' instead of chaotic and more 'controlled' (as is normally the case). This distortion I attribute to a temporary decrease in the number of degrees of freedom in the System from $n > 2$, implying chaotic dynamics, to $n = 2$, implying periodic dynamics. These abnormal, non-chaotic, non-systemic war dynamics caused a delay in the unfolding and development of the singularity dynamic. I argue that the second systemic war was delayed by about 13 years.

I also argue that the abnormal war dynamics during the first exceptional period (1657-1763) caused energy inefficiencies – an overproduction of tensions of which the extreme severities of wars during that period are symptomatic – and a shift in the energy release distribution (energy release ration of the second cycle). I calculated the overproduction of tensions and destructive energy was about 31 percent for the second cycle.

3 ***Finite-size effects cut the singularity dynamic short***
When the System in 1939 approached the singularity in finite time (the critical connectivity threshold of the anarchistic System), it was confronted with finite-size effects, the analysis suggests. Theoretically, had finite-size effects not constrained its dynamics, the System could have produced a fifth systemic war. The theoretical model suggests that a fifth systemic war would have started nine years after completion of the fourth systemic war, in 1954 (the 'calculation' is based on an extrapolation of the life span of successive relatively stable periods of the first finite-time singularity dynamic).

4 ***The fourth systemic war (the Second World War, 1939-1945) constituted a dual-phase transition and marked the globalization of the System; this 'globalization effect' resulted in a longer duration and increased severity of this war***
The fourth systemic war (the Second World War, 1939-1945) constituted a dual-phase transition that also marked the moment the System developed from a European-centric System to a global System. It is possible, based on the deterministic shortening of successive cycles, to determine the theoretical duration of the fourth systemic war, if this globalization effect is ignored. The theoretical model suggests that the lifespan of the fourth systemic war (the Second World War) would have been 2.5 in case of an 'Europe only' scenario.

Not only should the duration of the fourth systemic war be reduced – if the globalization effect is ignored – but also its severity: The theoretical model suggests that about 13 percent of the destructive energy, measured by severity (in terms of BCD), was deployed outside Europe.

These distortions explain (most of) the differences between the actual finite-time singularity as it unfolded in the period 1939-1945, and the theoretical (undistorted) finite-time singularity dynamic, as presented and discussed in this paragraph.

If the time-scale of the life span of the finite-time singularity is taken into consideration, the differences between the actual and theoretical finite-time singularity dynamics are not significant; except for the energy-inefficiencies caused by the abnormal war dynamics during the first exceptional period (1657-1763); the singularity dynamic is remarkably robust, and is obviously not easily distorted.

Most significant distortions and corrections applied to the theoretical model			
	Distortion	Cause of distortion	Correction
1	Start date first international order (of the System) too late	Methodological shortcoming	1495 must be 1480
2	Delay in the unfolding of the second cycle (1648-1792)	Abnormal war dynamics during the first exceptional period (1657-1763)	Caused a delay of 13 years.
3	Energy inefficiency (1): Overproduction of tensions and hyper-excited war dynamics during the first exceptional period: Increased total severity of the second cycle.	Abnormal war dynamics during the first exceptional period (1657-1763)	A reduction of 31 percent in the total severity of the actual second cycle.
4	Energy inefficiency (2): distortion in the energy release distribution (release ratio)	Abnormal war dynamics during the first exceptional period (1657-1763)	Resolved through other corrections
5	Lengthening of the duration of the fourth systemic war (the Second World War, 1939-1945)	Globalization effect	Correction of 3.5 years on the actual duration of the fourth systemic war (6 minus 2.5)
6	Increased severity of the fourth systemic war (the Second World War, 1939-1945)	Globalization effect	Minus 13 percent of the severity of the actual fourth systemic war
7	Collapse of the anarchistic System in 1939, no fifth cycle.	Finite size effects	Not applied in theoretical model

Table 44 *In this table I show the most important distortions I identified in the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) and the corrections that were applied to the theoretical model.*

4.4 Fine-tuning of the theoretical model

Construction of the theoretical – undistorted – version of the finite-time singularity dynamic includes the 'fine-tuning' of its parameters and properties.

The corrections I discussed in the previous paragraph, are also based on this (iterative) process of fine-tuning.

The fine-tuning is based on two assumptions: (1) that the relationships between variables and properties I propose in this study are correct, and (2) that the properties of specific variables of the finite-time singularity dynamic accompanied by four accelerating cycles should develop regularly. The second assumption is related to the observation that physical laws apply to the System's dynamics and development, and that the System is (as a consequence) highly deterministic in nature.

I assume that the correlation coefficients presented in the below tables concern causal relationships (I also discuss in this study), and can be considered a measure for consistency of the singularity dynamic.

		Actual										
		1	2	3	4	5	6	7	8	9	10	11
1	Severity cycle	X										
2	Severity IO	-0.24	X									
3	Severity SW	0.90	-0.63	X								
4	LS cycle	-0.85	0.71	-0.99	X							
5	LS IO	-0.80	0.72	-0.96	0.99	X						
6	LS SW	-0.82	0.49	-0.87	0.79	0.69	X					
7	No. non-sw	-0.95	0.49	-0.98	0.93	0.87	0.93	X				
8	Intensity cycle	0.87	-0.50	0.91	-0.94	-0.96	-0.61	-0.85	X			
9	Intensity IO	-0.22	1.00	-0.62	0.70	0.71	0.47	0.47	-0.49	X		
10	Intensity SW	0.81	-0.67	0.94	-0.90	-0.83	-0.97	-0.95	0.72	-0.65	X	
11	Pop size Eur.	0.89	-0.56	0.96	-0.91	-0.83	-0.97	-0.99	0.77	-0.54	0.99	X

Table 45 *This table shows the correlation coefficients of properties of the actual finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945).*
'Severity cycle' stands for the sum of the severities of all wars (non-systemic and systemic) of successive cycles. severity in BCD; 'Severity IO' stands for the sum of the severities of non-systemic wars during successive international orders. severity in BCD; 'Severity SW' stands for the severity of systemic wars of successive cycles. severity in BCD; 'LS cycle' stands for the lifespan of successive cycles in years; 'LS IO' stands for the lifespan of successive international orders in years; 'LS SW' stands for the lifespan of systemic wars in years; 'No. non-sw' stands for the absolute number of non-systemic wars during respective cycles; 'Intensity cycle' stands for the intensities of successive cycles, intensity defined as its total severity of wars during cycles divided by their respective life spans; 'Intensity IO' stands for the intensities of successive cycles, intensity defined as its total severity of non-systemic wars during successive international orders divided by their respective life spans; 'Intensity SW' stands for the intensity of systemic wars, intensity defined as the severity of systemic wars, divided by their lifespan; 'Pop size Eur.' stands for the populations size of Europe, at the start of the systemic wars of successive cycles.

Actual												
		1	2	3	4	5	6	7	8	9	10	11
1	Severity cycle	X										
2	Severity IO	-1.00	X									
3	Severity SW	1.00	-1.00	X								
4	LS cycle	0.84	0.96	-0.96	X							
5	LS IO	-0.92	0.92	-0.92	0.99	X						
6	LS SW	-0.96	0.96	-0.96	0.88	0.82	X					
7	Number non-sw	-1.00	1.00	-1.00	0.95	0.92	0.96	X				
8	Intensity cycle	0.84	-0.84	0.84	-0.95	-0.98	-0.69	-0.83	X			
9	Intensity IO	0.71	-0.71	0.71	-0.87	-0.92	-0.54	-0.70	0.98	X		
10	Intensity SW	0.95	-0.95	0.95	-1.00	-0.99	-0.88	-0.94	0.94	0.87	X	
11	Pop size Eur.	0.98	-0.98	0.98	-0.93	-0.88	-0.99	-0.97	0.77	0.63	0.93	X

Table 46 *This table shows the correlation coefficients of properties of the 'corrected' - undistorted - singularity dynamic. The fine-tuning is based on a model of the finite-time singularity dynamic. that is accompanied by four (not five) accelerating cycles. In this model, the globalization effect, is not included; the model represents 'Europe only'.*
'Severity cycle' stands for the sum of the severities of all wars (non-systemic and systemic) of successive cycles, severity in BCD; 'Severity IO' stands for the sum of the severities of non-systemic wars during successive international orders, severity in BCD; 'Severity SW' stands for the severity of systemic wars of successive cycles, severity in BCD; 'LS cycle' stands for the lifespan of successive cycles in years; 'LS IO' stands for the lifespan of successive international orders in years; 'LS SW' stands for the lifespan of systemic wars in years; 'No. non-sw' stands for the absolute number of non-systemic wars during respective cycles; 'Intensity cycle' stands for the intensities of successive cycles, intensity defined as its total severity of wars during cycles divided by their respective life spans; 'Intensity IO' stands for the intensities of successive cycles, intensity defined as its total severity of non-systemic wars during successive international orders divided by their respective life spans; 'Intensity SW' stands for the intensity of systemic wars, intensity defined as the severity of systemic wars, divided by their lifespan; 'Pop size Eur.' stands for the populations size of Europe, at the start of the systemic wars of successive cycles.

I calculated the average of the absolute values of the 55 correlation coefficients of the actual and theoretical (undistorted) finite-time singularity dynamics; I name the average the 'consistency index' of the finite-time singularity dynamic. I consider the consistency index a measure for the consistency of the finite-time singularity dynamic. The consistency indices of the actual and theoretical singularity dynamic are respectively 0,78 and 0,90.

5 The System depicted as a binary network of war switches

5.1 Schematic representation of the System as a network of binary switches

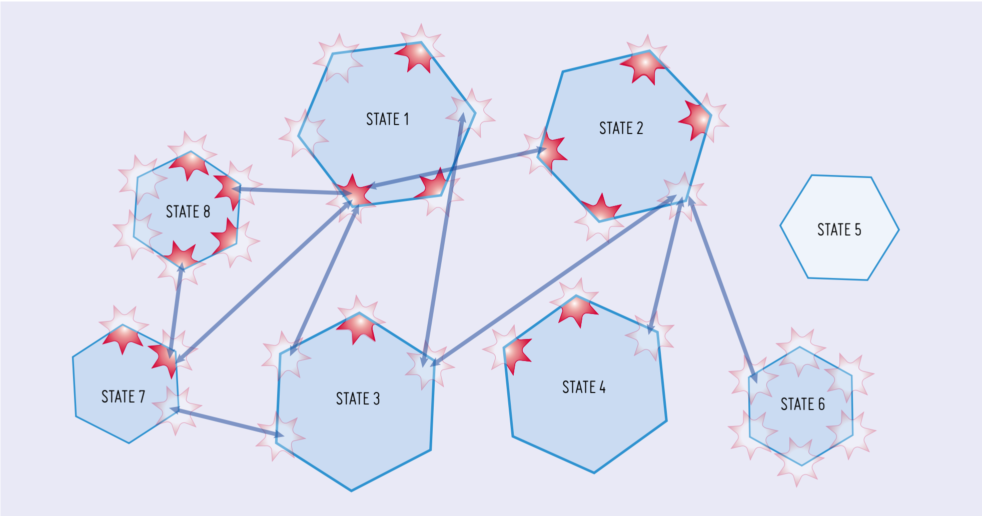


Figure 44 *This figure depicts the System as a network of binary 'war switches'. States constitute the switches (nodes) in this network. States are integral components of the network of vulnerable issue clusters. Vulnerable issue clusters are one step from being activated and producing a war (energy release). I assume that states are linked to (are integral parts of) a number of issues (and issue clusters) that during relatively stable periods develop in the System. The connectivity of the issue network determines if the System is in a low- or high-connectivity regime.*
In above figure, states are depicted as (blue) hexagons. Issues states have, are shown as ('thorny') stars. Issues of states can either be 'vulnerable' (depicted in dark red, one step from being activated in war) or 'not vulnerable'. Connectivity of states (to the issue network) and thresholds states use to decide to go to war (or not), determine the dynamics of the issue network and of the properties (size and frequency) of war dynamics in the System. In the present international order, the 'South China Sea' and the 'Ukraine' can be considered issue clusters.

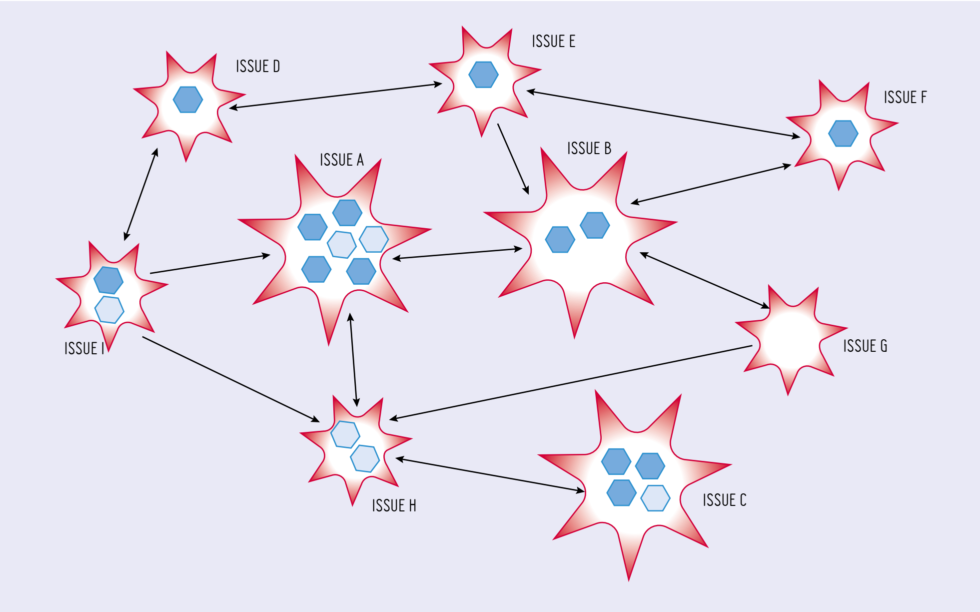


Figure 45 *This figure depicts the System as a network of binary switches from an issue perspective. Thorny stars depict issues. Issues 'contain' states, which are depicted as hexagons. Dark blue hexagons represent states for which the issue is 'vulnerable' (one step from being activated in war). Issues and states constitute a dynamic network.*

5.2 Explanation of the model

To a very high degree, states base war decisions ('war' or 'no war') regarding issues they are confronted with in the System, on war decisions of other states. War decisions qualify as binary decisions with externalities and thresholds. Issues are defined by the positions of states regarding these and other issues. States apply decision thresholds to issues. A decision threshold determines when a state switches to a favorable war decision.

Decision thresholds can be represented by fractions. A decision fraction is defined as the ratio of the number of states that switch to a positive war decision regarding a particular issue to the total number of states that are linked to the issue. If the decision threshold fraction is exceeded, states switch to a positive war decision.

Issues, thresholds, and positions of states are not static, but develop and evolve. States and issues are linked and form a dynamic network. If an issue is one step, that is, one additional positive war decision of a connected state, from activating a war, the issue is considered vulnerable. Issues are connected, and a single switch to war can – depending on the properties of the network – cause a cascade of wars as in a domino effect.

The connectivity of the vulnerable issue network and the decision thresholds that states apply determine the dynamics (the sizes and frequencies) of non-systemic wars during relatively stable periods. Typically, during relatively stable periods, low- and high-connectivity regimes – limited by a tipping point – can be identified. The moment the tipping point is reached, states become locally stable as a consequence of their high-connectivity in the issue-network. Their increased local stability starts constraining the size of non-systemic wars and the ability of the System to release free energy; instead of being released, the tensions that build-up during that phase (the high-connectivity regime) are temporarily 'stored' in the System, and crystallize in underlying vulnerable issue clusters. When these vulnerable issue clusters percolate the System, the System becomes critical and produces a systemic war, to implement an upgraded order that enables a lower energy state of the System.

The finite-time singularity accompanied by four accelerating cycles that the System produced during the time frame 1495-1945 was remarkably consistent and robust, implying that the underlying mechanisms and dynamics that produced the singularity dynamic were largely unchanged over time.

A network of binary switches is at the heart of the singularity war dynamic of the System. The consistency of the singularity dynamic shows that the nature of decision-making of units (states) in the System regarding war did not change over time, and is – it seems – independent of the exact nature of these units.

6 The System depicted as a slowly-driven, interaction-dominated threshold system.

6.1 Explanation of the System depicted as a slowly-driven, interaction-dominated threshold system

The anarchistic System, the finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period, qualifies as a slowly-driven, interaction-dominated threshold system (32).

To qualify as a slowly-driven, interaction-dominated threshold system, a number of conditions must be met:

1) ***Interaction-dominated***. The System consisted (and still consists) of a high number of components (populations, units, states, and issues) that regularly interacted on the basis of certain rules. The purpose of these interactions was (and still is) the fulfillment of a set of basic requirements, necessary for their survival. These interactions dominate(d) - and determined and shaped - the dynamics of the System. In case of the anarchistic System the multitude of 'micro' interactions between its components, especially states, to ensure the fulfilment of their basic requirements and survival, resulted in emergent self-organized macro dynamics; the finite-time singularity dynamic. The finite-time singularity dynamic accompanied by four accelerating cycles unfolded remarkably regular, and was instrumental in the establishment of a next level of SIE.

2) ***Rules***. Two sets of rules determine and shape interactions: physical laws and other deterministic mechanisms and principles in the deterministic domain of the System (for example, the second law of thermodynamics and related principles), and rules in the contingent domain of the System, including decision rules regarding conflict interactions. Development of certain structures and regular dynamics in the System can be attributed to the consistent application of these rules.

3) ***Slowly-driven***. The singularity dynamic was driven by the incompatibility between connectivity and security that causes issues and tensions (free energy) in anarchistic systems. Connectivity growth of the issue network (for example, caused by population growth and rivalry between states) is a relatively slow driver of the System, and in combination with the ability of the System to maintain itself in a metastable condition, allowed the System to experience relatively stable periods that permitted further growth and the balanced fulfillment of basic requirements. ***A separation of time scales***. Connectivity growth produced tensions and free energy in the System; this is a much slower process than the release events (wars) the anarchistic System produces as a consequence. The slow build-up of free energy and its fast release through wars work at different time scales. Thresholds and metastability enabled the separation of time scales.

4) ***Thresholds and metastability***. A separation of time scales in the System was achieved through thresholds and metastability. Thresholds allow for the buildup and storage of tensions and free energy in the System. The ability of the System to maintain itself for an extended time in a configuration other than the System's state of least energy is indicative for its metastability. The local stability of states that was created during high-connectivity regimes of relatively stable periods further enabled the storage of free energy, and also acted as a local threshold (as defined by Jensen). This effect refers to the deterministic domain.

   In the contingent domain, structural stability is achieved through forces that maintain the status quo and resists forces for change (also referred to as inertia of the System, for example, because such rigidity serves their interests). Great Powers that were successful in embedding certain privileges in the international order had a special interest in ensuring the status quo.

   Intrinsic properties of the System during relatively stable periods controlled its dynamics. As the abnormal war dynamics during the exceptional period show, the number of degrees of freedom are an integral component of the control properties of the System. More than two degrees of freedom produced chaotic war dynamics that restrained the size, intensity, and severity of the wars the System produced; chaotic dynamics requiring more than two degrees of freedom, in fact, constituted an internal control mechanism.

   When the number of degrees of freedom of the System was reduced to two, this internal control mechanism was neutralized and non-systemic war dynamics became more extreme. Two degrees of freedom producing periodic dynamics allow for a higher energy state. When n = 2, the dynamics of the System were dominated by tensions produced by connectivity growth of the issue network. Abnormal periodic dynamics impacted on the performance and evolvability of the finite-time singularity dynamic, causing inefficiencies and a time delay in its unfolding.

5) ***Criticality***. During the unfolding of the singularity dynamic (1495-1945), the System became critical four times, and produced four systemic wars as a consequence. Criticality implies a correlation length that spans the System (a correlation length of one), and that enables system-wide communication, coordination, and planning necessary for the design and implementation of an upgraded order that better matches the free energy produced as a consequence of the intrinsic incompatibility between connectivity and security of the anarchistic System.

   In the terminology of this perspective, a slow driver, connectivity, pushes the System to a critical point. When the System eventually reaches the critical point, free energy is released in a relatively short period of time through systemic war. Local stability of the System has a threshold effect. Internal control mechanisms (e.g., a third degree of freedom introducing chaotic dynamics) allow for metastability.

7 The System depicted as a dynamical system

7.1 Introduction

From a dynamical system perspective, the dynamics of a system are to a high degree determined by its feedback structures and how they interact. In the System there were (and are) multiple interacting feedbacks at play, and in some cases the dominance of a certain feedback structure (loop-dominance) changed over time, depending on certain conditions of the System.

In this section, causal loop diagrams are shown for the following phenomena and their feedback structures: (1) connectivity growth, (2) the security dilemma, (3) interacting self-fulfilling prophecies, (4) intrinsic incompatibility of increasing connectivity and security in anarchistic systems, (5) cyclic dynamics that accompany the finite-time singularity dynamic, and (6) competition between order versus disorder during the life span of cycles.

7.2 Connectivity growth

7.2.1 Causal loop diagram related to feedback structures of connectivity growth

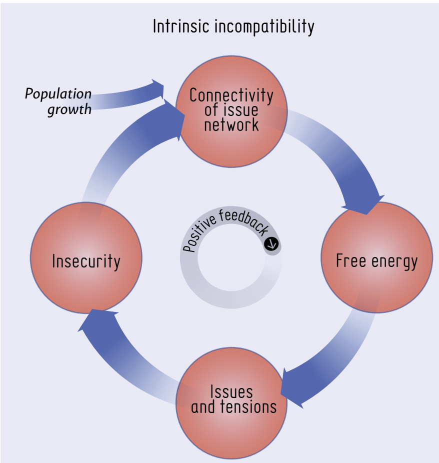


Figure 46
This figure shows variables that impact on the connectivity of the System, the System's driver, and how they interact. The connectivity of the System continuously grew at an increasing rate related to the growth rate of the population of the System during the unfolding of the singularity (1495-1945). The security dilemma itself constitutes a positive feedback mechanism and is (itself) also an integral component of the positive feedback mechanisms shown in this causal loop diagram.

7.2.2 Explanation of the causal loop diagram

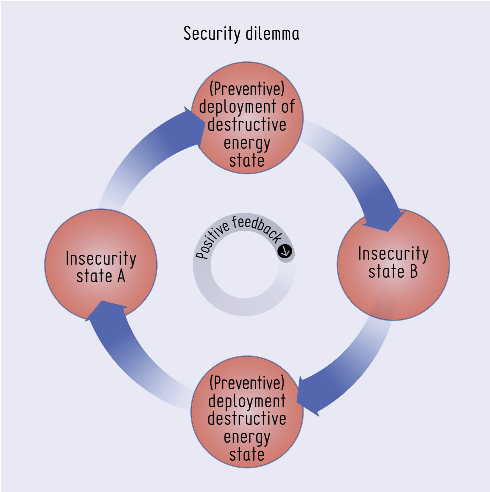
A number of variables impacted the connectivity of the System. This study is especially concerned with the connectivity of the network of issues and states. I consider population growth the basic driver of the System's connectivity. In order for humans, societies, and populations to survive, a number of basic requirements must be fulfilled. The fulfillment of these growing requirements, given the growth of the population of the System, required an increasing number of interactions and connections. An increase in the average age of populations and higher welfare expectations also contribute(d) to the increasing demands for resources.

Populations are organized in states; clusters of humans that leverage economies of scale and scope (synergies) to better fulfill their basic requirements and improve their survival changes. States are responsible for the security of their populations in an anarchistic System. Population growth implies increased connectivity and increased interdependence. Increased interdependence in an anarchistic system, despite its contribution to the fulfillment of the basic requirements of populations, also results in increased insecurity. In the anarchistic System, states compete(d) for scarce resources. Increased connectivity also implies increased rivalry. In an anarchistic System the security dilemma increasingly contributed to the tensions in the System.

7.3 The security dilemma

7.3.1 Causal loop diagram of feedback structures related to the security dilemma

Figure 47
This figure shows the workings of the security dilemma, an integral component of anarchistic systems.



7.3.2 Explanation of the causal loop diagram.

The security dilemma qualifies as a self-reinforcing positive feedback mechanism, and is an integral component of anarchistic systems. In anarchistic systems, states are ultimately responsible for their own security. One state's security, typically achieved through a combination of destructive energy and alliances, is another state's insecurity. The state that feels insecure will enhance its security by producing, preventively mobilizing, and deploying destructive energy, and by creating its own alliances. This then affects the sense of security of other states, setting in motion a self-reinforcing mechanism that creates more tensions and new issues. Through the security dilemma issues and tensions create more issues and tensions, etc.

7.4 Interacting self-fulfilling prophecies

7.4.1 Causal loop diagram of feedback structures related to interacting self-fulfilling prophecies

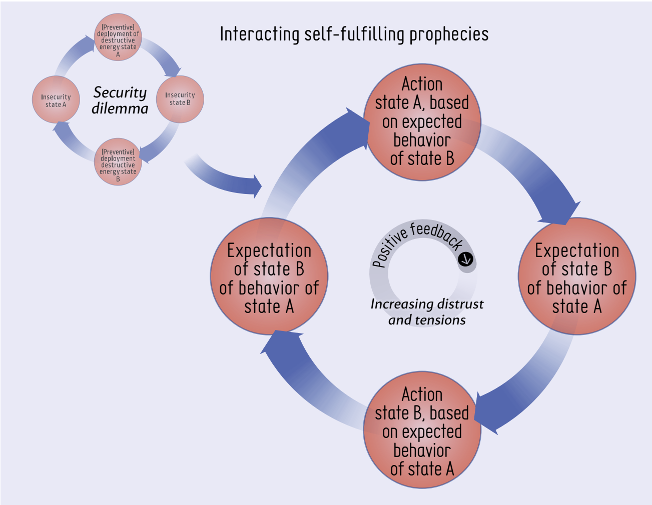


Figure 48
This figure shows the interactions between variables that make up interacting self-fulfilling prophesies in the System.

7.4.2 Explanation of the causal loop diagram

Interacting self-fulfilling prophecies constitute a very powerful mechanism that produced and shaped (and still produces and shapes) tensions, issues, and the structure of underlying vulnerable issue clusters in the System. This positive feedback mechanism is closely related to the security dilemma. In an anarchistic system, there is a certain level of distrust regarding the intensions of other states, especially rivals, and to what extent they could pose a threat to the fulfillment of basic requirements.

In an anarchistic system, perceived threats by state A sometimes provoke precautionary actions by state B, for example the preventive deployment of destructive energy. Countermeasures by state A confirm state B's distrust of state A, and start a self-reinforcing loop. This is a self-fulfilling prophecy. Interacting self-fulfilling prophecies produce and shape issues and tensions.

Through interacting self-fulfilling prophecies states can justify their interactions. Because of this powerful mechanism, it is not difficult in anarchistic systems to prove oneself right. A perceived threat, even if it is just imagined, has a high change of becoming true. Through interacting self-fulfilling prophecies, every state can produce and justify its actions and intensions, creating its own reality.

Interacting self-fulfilling prophecies act as an interface between the deterministic and contingent domain of the System, as I explain elsewhere in this study.

7.5 Intrinsic incompatibility between increasing connectivity and security in anarchistic systems.

7.5.1 Causal loop diagram of feedback structures and dynamics related to the incompatibility between connectivity and security in anarchistic systems.

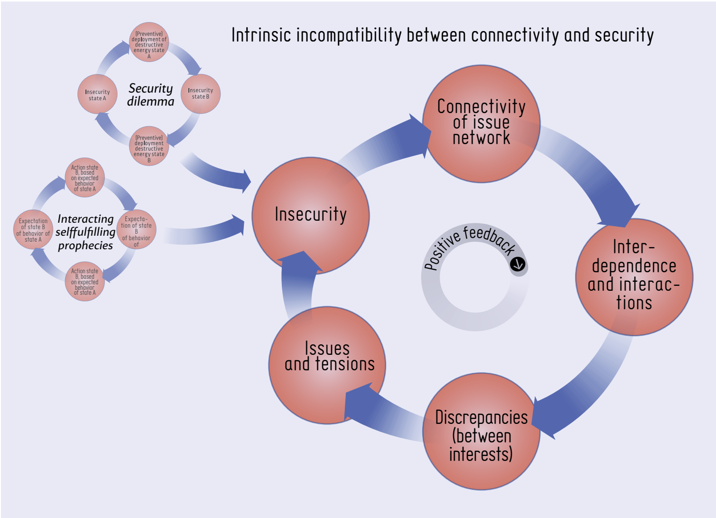


Figure 49
This figure shows the self-reinforcing dynamics that are caused by the intrinsic incompatibility between connectivity and security in anarchistic systems, and how it results in the production of free energy.

7.5.2 Explanation of the causal loop diagram

Increasing connectivity and security are intrinsically incompatible in anarchistic systems, and as a consequence of this intrinsic incompatibility an anarchistic system produces free energy (tensions in the contingent domain of the System).

In the contingent domain, this intrinsic incompatibility is contained in the contradictory effects of increasing interdependency of states. Increasing interdependence in anarchistic systems, on the one hand contributes to the ability of states to more effectively and efficiently fulfill their basic requirements, but on the other hand – 'at the same time' – also produces issues and tensions (free energy) that negatively affect its performance, and to which the second law of thermodynamics apply.

7.6 Cyclic dynamics that accompany the finite-time singularity dynamic

7.6.1 Causal loop diagram concerning the cyclic dynamics of the singularity dynamic

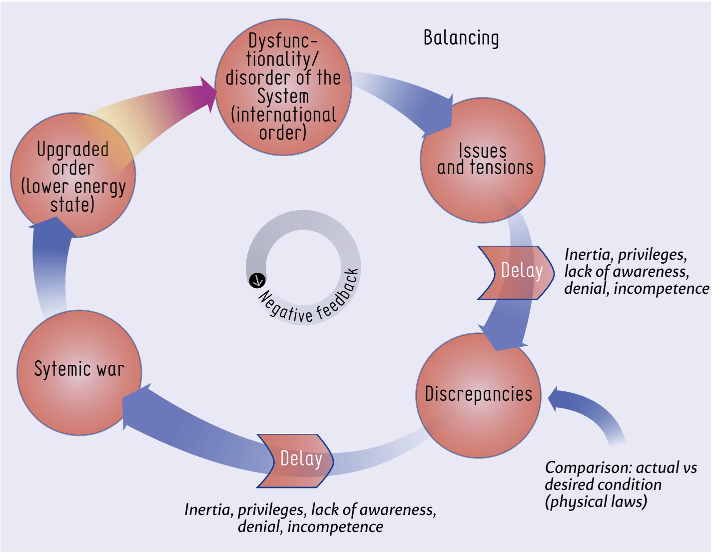


Figure 50 *This figure shows the balancing negative feedback mechanism that produced the four cycles that accompanied the finite-time singularity dynamic (1495-1945). Because corrective action through systemic wars are delayed responses of the System to disorder, systemic wars cause overshoot effects. The accelerating frequency of the four cycles can be attributed to the increasing connectivity of the System, causing an increase in its pace of life and the spreading of tensions in the System.*

7.6.2 Explanation of the causal loop diagram

As Sterman explains (69), oscillations (cycles) are generated by negative feedback with delays. The cycles in the war dynamics of the System can be attributed to delayed corrective actions of the System to implement new orders through systemic wars, as determined by the second law of thermodynamics. The delays were (and still are) caused by the (meta)stability of the System through international orders; international orders have the effect of thresholds, that allow for the build-up of tensions (free energy) in the System.

New orders were only temporarily effective in maintaining structural stability. Because of the continuously increasing connectivity of the System and the intrinsic incompatibility between increasing connectivity and security in anarchistic systems, free energy was produced at an increasing rate. As a consequence, the second law of thermodynamics forced the System to re-order at an increasing pace.

At a certain point, however, when the critical connectivity threshold of the System was reached (1939), free energy (tensions in the contingent domain) was produced at an infinite rate, requiring systemic wars to produce new orders at an infinite frequency. As a consequence of these 'infinite requirements', the anarchistic System could not find a viable order anymore and collapsed. At that point the System experienced a dual-phase transition (1939-1945) and simultaneously two dedicated hierarchies were implemented in Europe (the core of the System), and the first global international order at the (now) global scale of the System.

Sterman explains that in the case of an oscillatory dynamic, the corrective action itself also experiences delays, causing an overshoot in the other direction. Systemic wars produce overshoot effects. This effect can be explained as follows: Destroying issues and tensions in the System by destroying the connectivity of the underlying network of vulnerable issue clusters, and implementing a new order caused a reset of the initial conditions and of the parameters of the System, respectively. This reset allowed for renewed growth of the issue network. The upgraded orders that were successively implemented in compliance with the second law of thermodynamics, were in each case more stable, robust and more fragile. These enhanced properties of successive upgraded orders, including their structural stability, robustness, and fragility, constitute the reset of the parameters of the System.

Systemic wars create space for new issue networks in two respects: by destroying the old network of issues and accompanying tensions, and by implementing an upgraded order. These effects qualify as an overshoot, as defined by Sterman.

Another example of oscillations in the war dynamics of the System can be observed in the non-systemic war dynamics during the first relatively stable period (international order). During this period of time (1495-1618), the System produced 45 non-systemic wars, that can be 'organized' - grouped – in nine orbits in phase state (defined by size and intensity of non-systemic wars), as I explain in this study, certain properties of these orbits – the average sizes of non-systemic wars constituting these cycles - did not develop arbitrarily, but can be depicted as a damped oscillation, that 'faded out' shortly before the System became critical in 1618 and produced a systemic war (the Thirty Years' War, 1618-1648). This damped oscillation was produced by delayed corrections states applied through non-systemic wars to re-establish a certain equilibrium in the international order that was temporarily disturbed.

A dynamic with these properties does make sense, not only from a (theoretical) dynamical system's perspective, but also from the perspective that states are motivated in their interactions (including war decisions) by the need to fulfill basic requirements to ensure their survival; an 'order' with a certain equilibrium is a prerequisite to achieve this in anarchistic systems. If this reasoning and argumentation is correct (as I argue), it also further confirms that these orbits are not artificial constructs, and that non-systemic war dynamics indeed are chaotic in nature as these orbits in phase state (also) suggest.

7.7 Competition between order and disorder during the life span of cycles

7.7.1 Causal loop diagram related to feedback structures and dynamics of cycles

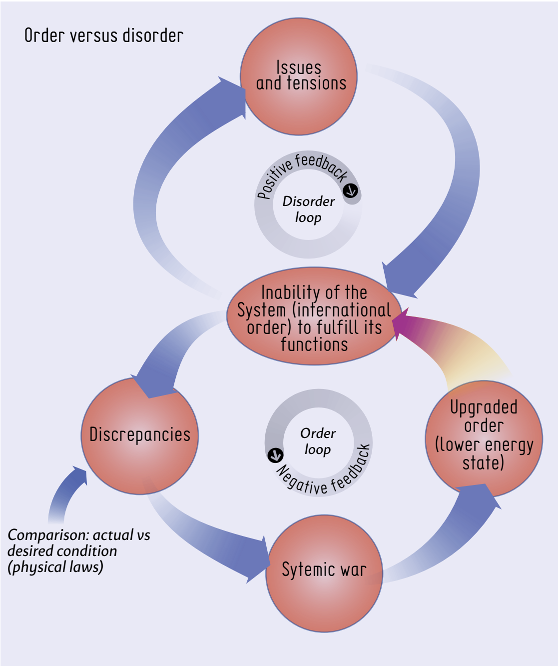


Figure 51
This figure shows the causal loop diagram of a single oscillation – a relatively stable period – followed by a systemic war. Two interacting loops can be identified: A positive feedback loop and a balancing negative feedback loop. The self-reinforcing positive feedback loop in this model consists of two variables: the inability of the international order to fulfill its function, and issues and tensions.
At a certain point, a vulnerable issue cluster percolates the System, and the System becomes critical; criticality results in systemic war. At that point the actual and desired state of the System as demanded by the second law of thermodynamics, can no longer be sustained. The order loop becomes dominant and ensures that an upgraded order is implemented (through a systemic war).

7.7.2 Explanation of the causal loop diagram

The finite-time singularity dynamic the System developed during the 1495-1945 period was accompanied by four accelerating cycles. All of the cycles developed similarly to the model depicted in this figure. When the System reached a critical condition (respectively in 1618, 1792, 1914 and 1939), a change in loop dominance took place. During relatively stable periods, dynamics of the System were dominated by self-reinforcing positive feedback mechanisms, causing increases in connectivity, but also in issues, and tensions. These tensions crystalized into underlying vulnerable issue clusters that eventually percolated the System. When the percolation condition was met, the System was critical and produced a systemic war. Through systemic war, the System re-established order, in compliance with the second law of thermodynamics.

The moment the System switched from relative stability to systemic war, a balancing negative feedback mechanism became dominant.

8 The System depicted as a path-dependent dynamic

8.1 Introduction

The dynamics of the singularity dynamic are path-dependent and increasingly locked-in on a dual-phase transitions, that became unavoidable as a consequence. This path-dependent dynamic can be approached from two complementary perspectives: a deterministic perspective and a contingent perspective.

It is possible to analytically distinguish between a deterministic and contingent domain in the System; these domains are complementary, and form an integrated dynamic. The distinction makes it possible to better understand the workings of the System, and how deterministic laws and properties interact with contingent variables and conditions. In this paragraph I apply this approach.

8.2 Path-dependency and lock-in in the deterministic domain of the System

In the deterministic domain, free energy is produced as a consequence of the intrinsic incompatibility between increasing connectivity and security in anarchistic systems. Connectivity increases at an accelerating rate, producing free energy at an accelerating and unsustainable growth rate. The singularity in finite time marks the point in time (1939) when the System reached its critical connectivity threshold and the System produced infinite amounts of free energy.

The second law of thermodynamics states that 'free energy will be put to work', and that, by doing so, 'order is implemented that enables a lower free energy state of the System'.

Four times during the 1495-1945 period, the second law of thermodynamics forced the System to re-order and implement increasingly stable orders that were better able to deal with the increasing levels of free energy the anarchistic System produced. These system-wide orders were implemented each time (four times in total) when the System reached a critical condition during the 1495-1945 period. Criticality implies a correlation length of one for the System, allowing for the system-wide communication, coordination, and planning that was necessary for the collective design implementation of upgraded system-wide orders.

Because of the accelerating growth in the connectivity of the System, the first three orders only offered a temporary solution for the System. Ultimately, when the anarchistic System reached in 1939 the critical connectivity threshold, it was confronted with infinite levels of free energy that threatened to destroy it. At that point, the no longer viable anarchistic System collapsed, and the second law of thermodynamics forced the System into another stability domain in which anarchy was neutralized. Through a phase transition, dedicated hierarchies were introduced in Europe that neutralized anarchy and the production of free energy; levels of free energy became manageable again, and the System, at least temporarily, complied with the second law of thermodynamics.

The same systemic war that produced two dedicated hierarchies in Europe, also produced the first global international order in the now-expanded globalized System. Both orders, Europe and the global stage, coevolved.

These dynamics qualify as a path-dependent dynamic: The production of free energy (tensions) by the anarchistic System, application of the second law of thermodynamics, the initial conditions of the System and the urge of its constituents to survive, caused the System to lock-in on increasing levels of order simultaneously in Europe and on the global stage. Positive feedback through the production of increasing levels of free energy, as a consequence of connectivity growth, powered these path-dependent dynamics.

8.3 Path-dependency and lock-in in the contingent domain of the System

The path-dependent dynamic, logic, discussed in the previous paragraph concerns the dynamics of the deterministic 'core' of the contingent path-dependent dynamic that developed simultaneously in the contingent domain of the System; it should be kept in mind that the distinction between a deterministic and contingent domain in the System, serves above all analytical purposes. Free energy manifests itself by tensions in the contingent domain. Increasing interdependence enhances the capability of states to fulfill their basic requirements, but also unavoidably produces new insecurity issues. The intrinsic incompatibility of interdependence and security in anarchistic systems produces tensions. Increasing connectivity means increasing interdependence and implies increasing levels of insecurity and tensions.

To fulfill their basic requirements, states require structural stability and predictability; structural stability and predictability in the contingent domain of the System were provided by international orders: collectively agreed upon arrangements that reflected the power and influence positions of states and provided rules that determine how states should interact. During systemic wars, dysfunctional orders are destroyed, and new orders are designed and implemented. Because of the increasing interdependence of states, caused by population growth and increasing connectivity, successive international orders contained increasingly far-reaching organizational arrangements.

The League of Nations (the arrangement following the third systemic war, the First World War, 1914-1918) was the maximal achievable arrangement that could be designed and implemented in the anarchistic System, before the anarchistic System ultimately collapsed, when it reached in 1939 the critical connectivity threshold. The ineffectiveness of the fourth international order (1918-1939, the League of Nations) shows that viable orders – that could effectively cope with the tensions that were produced in the System – could no longer be designed and implemented in an anarchistic System.

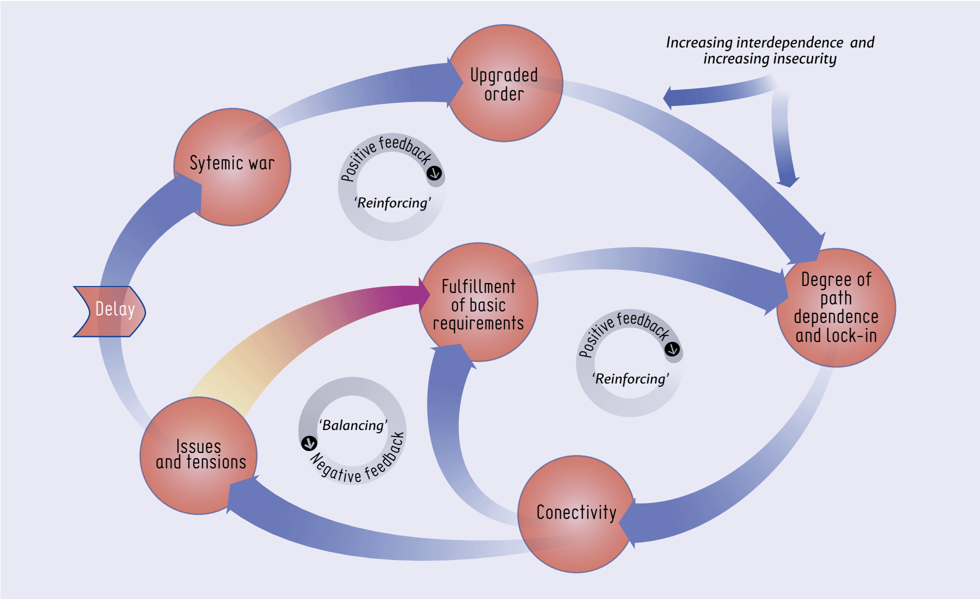
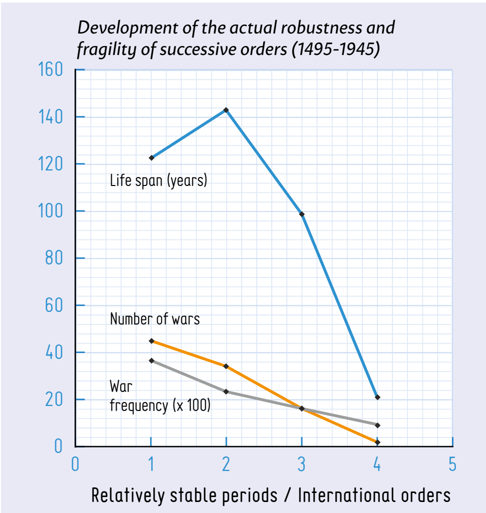


Figure 52 *This figure shows the relationships between variables in the System that produce a positive feedback mechanism that results in increasing path dependence and lock-in towards increasing interdependence of states and increasing levels of insecurity.*

An integral component of the path-dependent dynamic – during the unfolding of the finite-time singularity dynamic (1495-1945) – was the coevolution of states and international orders. This co-evolutionary process provided a mechanism that ensured that successive international orders contained increasingly far-reaching arrangements – structural stability – as required by underlying deterministic laws. This co-evolutionary mechanism also contained a positive feedback mechanism that I refer to as the 'powerful-get-more-powerful effect.'

Figure 53
The robustness, structural stability, and fragility of successive international orders increased linearly over time, and reached 'absolute' levels when the System reached the critical connectivity threshold and collapsed in 1939. In this figure the development of the life spans of successive orders is shown in blue; this is a measure for the fragility of the System, and of the absolute number of non-systemic wars (eight expansion wars excluded) and of the war-frequency of successive international orders in respectively orange and grey; both measures for the robustness of the System.



9 The System (1495-1945) depicted as a sequence of phases with different dynamics and levels of criticality

9.1 Schematic depiction of types of dynamics and levels of criticality of the System during the 1495-1945 period

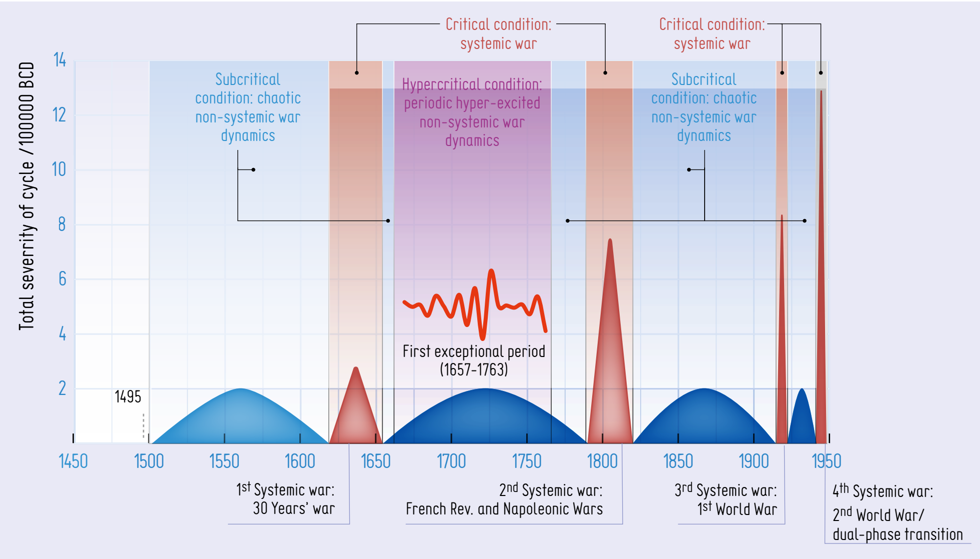


Figure 54 *This figure shows the different types of dynamics that can be identified during the unfolding of the first finite-time singularity dynamic (1495-1945), and with what levels of criticality they correspond.*

9.2 Explanation of the different phases

It is possible to identify different types of dynamics during the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945); different types of dynamics correspond with different degrees of criticality, as I explain in this paragraph.

During each of the four cycles consisting of relatively stable periods followed by systemic wars, the System, with one exception, produced similar dynamics. During relatively stable periods, non-systemic war dynamics were chaotic in nature; only during an exceptional period (1657-1763) within the second relatively stable period (1648-1792), chaotic dynamics were temporarily disturbed. Due to a decrease in the number of degrees of freedom in the System, attributable to the intense rivalry during the exceptional period, the System temporarily produced periodic dynamics, consistent with rules that govern dynamical systems.

The number of other states that states take into consideration regarding war decisions determines the number of degrees of freedom of the System. During the exceptional period, Great Britain and France dominated the System's dynamics completely. The temporary decrease in the number of degrees of freedom from n > 2 (chaotic dynamics) to n = 2 (periodic dynamics), caused a 'downgrade' in the non-systemic war dynamics of the System from chaotic to periodic. Periodic war dynamics have fundamentally different properties (see table below).

Properties of chaotic and non-chaotic non-systemic war dynamics	
Chaotic	Periodic
Degrees of freedom > 2	Degrees of freedom = 2
Default non-systemic war dynamics	Abnormal non-systemic war dynamics
Intrinsically unpredictable	More regular and more predictable
More constrained in size and severities	More extreme in size and severities in case of periodic non-systemic war dynamics during the first excepti-onal period (1657-1763), subdued during the second exceptional period (1953-1989)
Contribute to the development of the System towards criticality	Hinder the development of the System towards criticality
Ensure optimality and efficiency	Cause delay and inefficiencies in the unfolding of the singularity dynamic; negatively affect optimality and efficiency

Table 47 *This table shows the different properties of chaotic and abnormal (periodic and subdued) non-systemic war dynamics.*

Whereas chaotic dynamics are intrinsically unpredictable, periodic dynamics are much more regular and predictable. Chaotic non-systemic war dynamics are also more balanced and less extreme than periodic dynamics. A third degree of freedom restrains states. As a consequence, non-systemic wars are more limited in size and less intense and severe.

Periodic non-systemic wars are not only more regular, but often are also more extreme. During periodic (n = 2) conditions war dynamics of the System reached higher unconstrained free energy states and became hyper-excited. The absence of a third degree of freedom and the inability of the System to produce chaotic non-systemic war dynamics this implied, negatively affected internal control properties of the System.

During relatively stable periods, the System was in a subcritical condition, except for the exceptional period (1657-1763) when the condition of the System qualifies as hypercritical (as I explain later, part VI where I discuss the term 'hypercritical' and potentially false interpretation).

Subcriticality implies that the correlation length of the System is lower than one; vulnerable issue clusters and wars the System produced were (for that reason) not system-wide. During subcriticality, system-wide communication, coordination, and planning, required for the design and implementation of new system-wide orders, are not possible ('enabled properties'). Non-systemic wars are local wars, with no significant impact on the order of the System.

As the war data of Levy shows, during the exceptional period (1657-1763) the System produced a number of system-wide and very intense wars. Despite the fact that these wars were system-wide, they do not qualify as systemic. These system-wide non-systemic wars were a consequence of the hyper-exited unrestrained state of the System during the exceptional period. These wars do not 'represent' criticality and were forced on the System as a consequence of the temporarily reduced degrees of freedom of the System that can be attributed to the intense rivalry between Britain and France.

The extreme dynamics the System produced during the exceptional period (1657-1763) are sometimes referred to as hyper-critical dynamics.

The dynamics and development of the System and finite-time singularity dynamic (1495-1945) suggest that chaotic non-systemic war dynamics are a prerequisite for the formation of vulnerable issue clusters with fractal structures, and a prerequisite for the System to become critical. Hyper-excited war dynamics lack restraint (during the first exceptional period 1657-1763), and contrary to chaotic dynamics, cannot produce (underlying) vulnerable issue clusters with fractal structures; the free energy (tensions) that are produced during hyper-excited conditions are 'immediately' released, and cannot be stored in the System.

When the intense rivalry between Great Britain and France was resolved in 1763, the System resumed chaotic war dynamics; the System after experiencing a temporary hypercritical period became subcritical again, formed underlying vulnerable issue clusters that percolated the System in 1792, resulting in the System's criticality and systemic war.

So, during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the System was normally subcritical during relatively stable periods, and critical during systemic wars; during the exceptional period (1657-1763) the System was hypercritical.

Through a phase transition (the fourth systemic war, The Second World War, 1939-1945) the System experienced a dual-phase transition that resulted in the simultaneous implementation of two dedicated hierarchies in the core of the System (Europe), and the first global order at a (now) global scale of the anarchistic System.

Following the phase transition, the System initially resumed its default chaotic war dynamics until 1953, when – I argue – the System experienced a second exceptional period (1953-1989) as a consequence of the intense rivalries between the United States and the Soviet Union, and the respective hierarchies they controlled. Contrary to the first exceptional period (1657-1763) these intense rivalries did not produce a hyper-excited condition, instead the war dynamics were subdued. Following the collapse of the Eastern hierarchy (1989), the System resume chaotic war dynamics.

The condition of the System during the period 1945-1953 qualifies as subcritical, during the second exceptional period (1953-1989) as 'subdued', and during the period 1989- present as subcritical again.

10 The System depicted as energy transfers

10.1 The System depicted as energy transfers

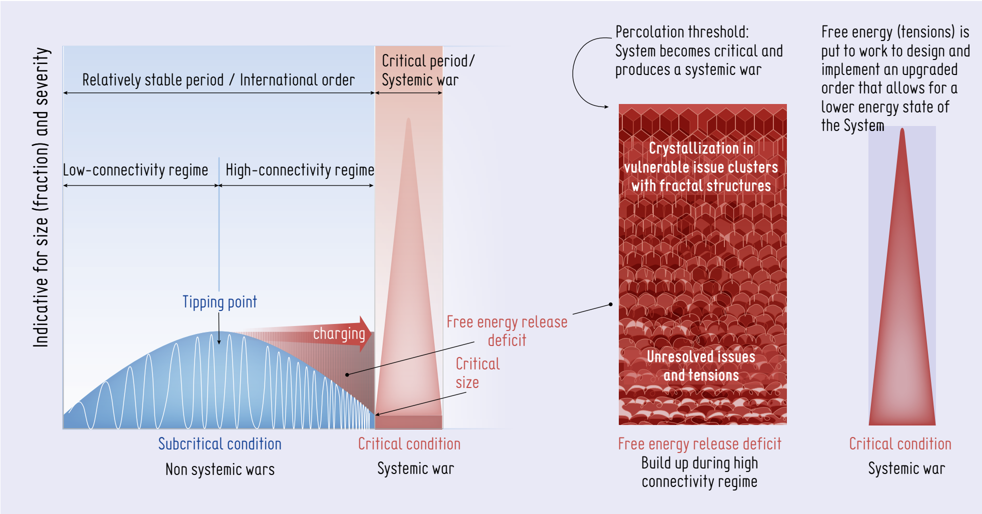


Figure 55 *This figure shows schematically the buildup of a free energy release deficit during the high-connectivity regime of a cycle. The deficit contributes to the formation of underlying vulnerable issue clusters that eventually percolate the System. Furthermore, the deficit enables a massive release of tensions and destructive energy when the System becomes critical and produces a systemic war.*

10.2 Free energy production and its use by the System

The intrinsic incompatibility between connectivity and security in anarchistic systems results in the production of free energy and tensions, in respectively the deterministic and contingent domain of the System. Free energy and tensions obey the second law of thermodynamics. In accordance with this law, tensions (free energy) are at a certain point put to work, to implement (upgraded) orders, that allow for lower energy states of the System. In the anarchistic System tensions are put to work through systemic wars. Tensions are transformed in alliance dynamics and destructive energy that is deployed during wars. I consider the severities of wars indications for the destructive energy that is deployed during these wars. I also assume that the destructive energy that is deployed during wars is indicative for the amount of free energy that is produced by the System.

The figure below shows the total severity of wars during successive cycles of the actual and theoretical finite-time singularity dynamic that unfolded in the anarchistic System during the 1495-1945 period; respectively in blue and red.

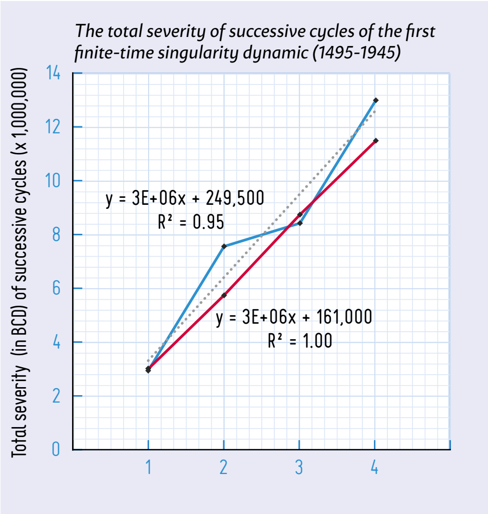


Figure 56
This figure shows the actual (blue) and theoretical (red) total severity of wars during successive cycles of the first finite-time singularity dynamic. The destructive energy deployed during successive cycles increased linearly, however because of the accelerating shortening of the life-span of successive cycles, its rate of production accelerated.

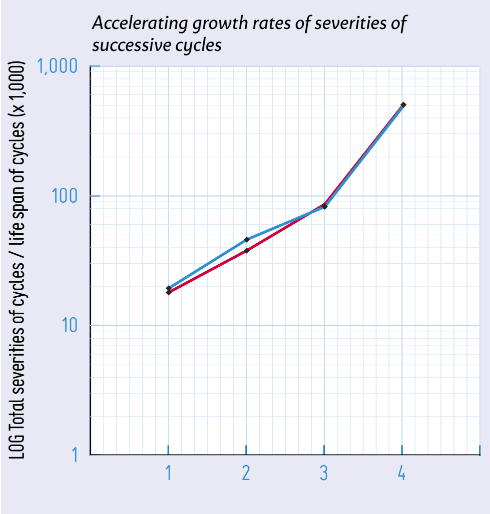
These distributions show that the total free energy production of successive cycles (during relatively stable periods and systemic wars that followed) increased linearly. Because the life span of successive cycles decreased at an accelerating rate, the free energy production and the increase in tensions, in fact increased at an accelerating rate when the factor time is taken into consideration.

Total severities and lifespans of cycles of the actual and theoretical finite-time singularity dynamics				
	Actual finite-time singularity dynamic 1495-1945 (Calculations based on data from Levy (38))		Theoretical finite-time singularity dynamic. (Data derived from model)	
Cycle	Total severity	Life span	Total severity	Life span
1	2.976.000	153	3.036.000	168
2	7.550.300	167	5.750.000	154
3	8.425.080	103	8.720.000	103
4	13.003.300	27	11.500.000	22,5

Table 48 *This table shows total severities and lifespans of cycles of the actual (1495-1945) and theoretical finite-time singularity dynamics.*

The figure below shows the accelerating growth of the severity of successive cycles of the actual and theoretical model of the first finite-time singularity dynamic (1495-1945), an indicator for the destructive and free energy produced and put to work by the System, with the cycles' life spans taken into consideration.

Figure 57
The figure shows the severities per year of wars during successive cycles (non-systemic and systemic) of the actual (blue) and theoretical model of the first finite-time singularity dynamic (1495-1945). I assume that the total severity is indicative for the free energy (tensions) that was produced during successive cycles, and for the destructive energy that is subsequently deployed.



10.3 Energy transfer: System-level.

From the perspective of this model, the dynamics and the development of the System are about the production, storage, transfer, and use of energy. Energy is needed to establish, maintain and change international orders. Physical laws, including the second law of thermodynamics and a number of principles related to this law (I refer to these principles as 'free energy principles'), also apply to the System and determine and shape its dynamics and development.

During the 1495-1945 period, the energy (tensions) levels, transfers and transformations in the System were 'regulated' by the finite-time singularity dynamic, which can be considered a product of the second law of thermodynamics.

The second law of thermodynamics and its principles determined when the System became (and will become) critical, for how long, and how much free energy had to be used to implement upgraded orders that could provide more structural stability to the System and allow for a lower free energy state. This law and its principles are the basis of the finite-singularity dynamic.

By demanding ever-higher levels of order, to accomplish lower energy states (a response to the accelerated amounts of free energy the System produced over time), the second law of thermodynamics 'facilitated' - in fact enforced - a process of social integration and expansion (SIE) in the System. The SIE process eventually, when the anarchistic System in 1939 reached the critical connectivity threshold, resulted in the simultaneous implementation of dedicated hierarchies in the core of the System (Europe), and the first global order at a global scale of the System. The two dedicated hierarchies in Europe order addressed in particular the 'European' situation (tensions); while the first global order addressed global tensions; both orders are closely related.

The second law of thermodynamics also determined when the critical threshold (the singularity in finite time, 1939) of the anarchistic System was reached, and determined that the just mentioned dedicated hierarchies and first global order where adequate responses of the System to meet the law's requirements for a lower energy state.

Not only can the finite-time singularity be interpreted as an energy transfer dynamic; energy transfers can also take place at the level of cycles.

10.4 Energy transfer: Cycle level

Connectivity is not just the driver of energy production in an anarchistic system; it also shapes energy redistribution and transfers.

The finite-time singularity dynamic (1495-1945) was accompanied by four accelerating cycles. Each cycle developed according to a similar logic. A cycle consisted of a relatively stable period (international order) followed by a systemic war. During a systemic war the dysfunctional preceding order was destroyed and replaced by an upgraded order that allowed for a lower free energy state, or lower tensions, in the System. The accelerating growth rate of free energy in the System contributed to the acceleration of successive cycles. The life span of an international order was relatively long compared to the life span of the systemic war that followed. However, relatively stable periods and systemic wars accelerated with about the same rate during the unfolding of the finite-time singularity dynamic (1495-1945), except for the fourth systemic war, the Second World War, 1939-1945, which had an extended life span because of the global component of the dual-phase transition; see below figure.

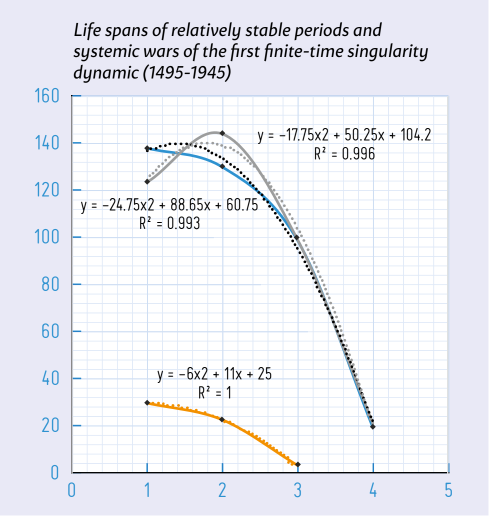


Figure 58

In this figure the life spans are shown of the actual relatively stable periods (international orders) in grey, of the theoretical (corrected) relatively stable periods (international orders) in blue, and of the first three systemic wars of the first finite-time singularity dynamic (actual), in orange; the fourth systemic war is excluded from this analysis because of a significant 'distortion' that can be attributed to the globalization effect. The correlation coefficient of the life spans of the first three relatively stable periods (actual) and of the first three systemic wars (actual) is 0.73, and the correlation coefficient of the first three relatively stable periods (theoretical) and of the first three systemic wars (actual) is 1.00.

Except for the exceptional period (1657-1763), non-systemic war dynamics were chaotic in nature; during the exceptional period non-systemic war dynamics were periodic, as explained.

During the life cycle of relatively stable periods (international orders), two regimes – a low- and a high-connectivity regime limited by a tipping point – can be distinguished. Typically, at the start of a relatively stable period, following a systemic war, the connectivity of the network of issues in the System is relatively low. When the connectivity increases, so does the production of free energy, and of the sizes of energy release events, that is, of non-systemic wars. During low-connectivity regimes of relatively stable periods, the sizes of release events – of non-systemic wars – is determined by its connectivity; increasing connectivity implies increasing average size of non-systemic wars.

When the tipping point is reached, the System reaches the high-connectivity regime of the relatively stable period. In the high-connectivity regime, the nodes (states) of the System become increasingly stable and the average sizes of non-systemic wars decrease as a consequence. This connectivity/local stability effect is caused by the nature of war decisions; war decisions qualify as binary decisions with externalities and thresholds.

However, although the average size of non-systemic wars decreases during high-connectivity regimes of relatively stable periods, the production of free energy (tensions) still continuously increases. Instead of being released, these tensions are 'stored' as unresolved issues in the System, and crystallize into underlying vulnerable issue clusters. These stored tensions, form a so-called free energy release deficit.

The moment the underlying vulnerable issue clusters percolate the System, the System becomes critical and produces a systemic war. During systemic wars, the free energy release deficit complemented with free energy (tensions) that is produced, is put to work to implement upgraded orders that allow for lower energy states of the System.

The temporary storage of unreleasable free energy – in other words of high-connectivity regimes during relatively stable periods that enable such a storage of tensions – is a requirement for the System to be able to produce systemic wars that have enough destructive energy available to ensure destruction of the 'old' dysfunctional order (that precedes such a systemic war), and for the design and implementation of an upgraded order that meets the requirements of the second law of thermodynamics.

Because of the hyper-excited (abnormal) non-systemic war dynamics during the exceptional period (1657-1763), the System could not reach the tipping point of the second relatively stable period (the second international order, 1648-1792), and produce a free energy release deficit and underlying vulnerable issue clusters, that could percolate the System and cause it to become critical.

Because of the increasing structural stability of successive international orders, successive systemic wars required increasing levels of destructive energy to ensure the implementation of upgraded orders.

In figure 53 I show that the robustness, structural stability, and fragility of successive cycles consistently increased. I argue that increased robustness and structural stability of successive relatively stable periods, in combination with the production of free energy at an increasing rate, were responsible for the acceleration of the frequency of successive cycles and the simultaneous acceleration of the severity of successive systemic wars, indicative of the free destructive energy that was deployed.

10.5 Energy transfer: Shifts in the energy release distribution – the release ratio – during successive cycles

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the energy release distribution during successive cycles shifted in favor of systemic wars. I define the ratio of the severity of the systemic war of a cycle and the total severity of all wars during the cycle, as the release ratio of a cycle. I consider the severities of wars indicative for the destructive energy that is deployed during wars, for the amount of free energy that is released.

The change in the energy release distribution can be attributed to the increasing robustness of successive relatively stable periods of cycles. Ultimately, when during the fourth relatively stable period (1918-1939), the anarchistic System became completely robust, the release ratio became one, meaning that all energy was (and only could be) released during the fourth systemic war (the Second World War, 1939-1945).

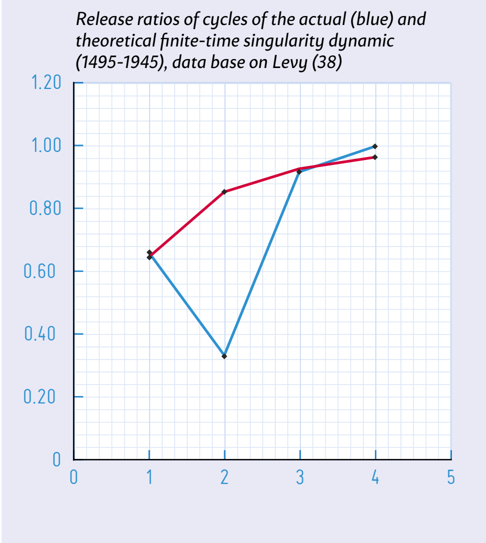
However, the development of the release ratio shows a significant distortion during the second cycle (1648-1815).

Release ratios of the actual and theoretical finite-time singularity dynamic (1495-1945)							
		Actual FTS (Severity in BCD)			Theoretical FTS (Severity in BCD)		
Cycle	Period	Severity systemic war	Total severity	Ratio	Severity systemic war	Total severity	Ratio
1	1495-1648	1,971,000	2,976,000	0.66	1,971,000	3,036,000	0.65
2	1648-1815	2,532,000	7,550,300	0.34	4,900,000	5,750,000	0.85
3	1815-1918	7,734,300	8,429,080	0.92	8,100,000	8,720,000	0.93
4	1918-1945	12,948,300	12,953,300	1.00	11,100,000	11,500,000	0.97

Table 49 *This table shows the release ratios of successive cycles of the actual and theoretical finite-time singularity which was accompanied by four accelerating cycles (1495-1945).*

If the ratios of the actual and theoretical finite-time singularity are plotted in a graph, the (just mentioned) distortion during the second cycle (1648-1815) is visible.

Figure 59
This table shows the release ratios of successive cycles of the actual (in blue) and theoretical (in red) finite-time singularity which was accompanied by four accelerating cycles (1495-1945). The distortion caused by the first exceptional period is clearly visible (1657-1763).



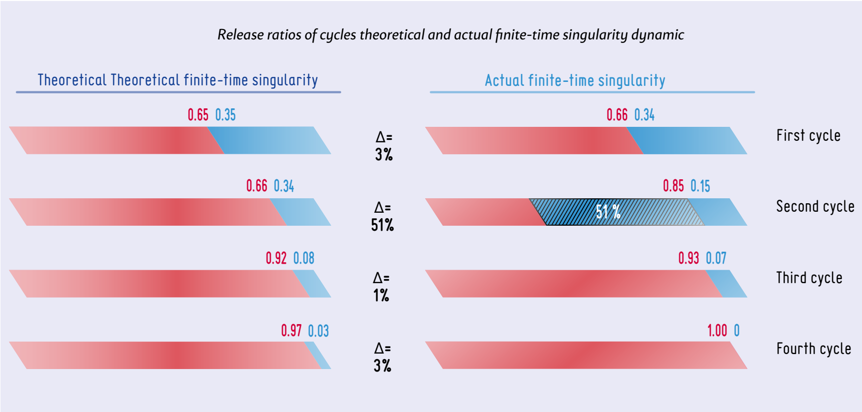


Figure 60 *In this figure the theoretical and actual release ratios are shown of the four accelerating cycles of the first finite-tvime singularity dynamic (1495-1945). This figure shows that ultimately (about) 100 percent of the free energy (tensions) was released through the fourth systemic war (the Second World War, 1939-1945). This effect can be attributed to the increasing robustness of successive relatively stable periods (international orders), as explained in this study. The distortion (51 percent) during the second cycle (1648-1815) is also clearly visible; this distortion I attribute to the abnormal (non-chaotic) non-systemic war dynamics during the first exceptional period (1657-1763).*

During the period 1657-1763 – I designated as the first exceptional period – the non-systemic war dynamics of the System were temporarily non-chaotic in nature, and produced a series of extreme non-systemic wars (in terms of size and severities), because the System during that specific period lacked a third – balancing – degree of freedom that would have produced chaotic non-systemic war dynamics.

The abnormal non-systemic war dynamics during the exceptional period (during the second cycle) had a number of effects, including: (1) an 'over-production' of free energy (tensions), resulting in a series of 'extreme' non-systemic wars, (2) a shift in the energy release distribution of the System, and (3) a delay in the unfolding of the second cycle (see also:...).

1 ***Over-production of free energy***
The abnormal non-systemic war dynamics resulted in an increase of 0,92 percent of the total severity of the cycle (0,92% of the population size at the start of the second systemic war.

2 ***A distortion in the release ratio of the second cycle***
Significantly more energy was released through non-systemic wars during the relatively stable period of the second cycle), than would be the case if the non-systemic war dynamics were not disturbed, as the theoretical model of the first finite-time singularity dynamic suggests. It seems that the increase in the energy-release through non-systemic wars, was (at least to a degree) 'compensated' by a significant lower release during the second systemic war (the French Revolutionary and Napoleonic Wars, 1792-1815); the actual release ratio was 0,34 instead of 0,85 (theoretical).

3 ***A delay in the unfolding of the second cycle***
This delay was about 13 years as this study suggests.

10.6 Energy transfer: Expansion of the core of the System

The finite-time singularity dynamic, accompanied by four accelerating cycles, had three system-level impacts: (1) the implementation of dedicated hierarchies in Europe when the singularity in finite time (the critical connectivity threshold) was reached in 1939; a dynamic that produced a process of integration in the contingent domain of the System, (2) the initiation of a process of expansion outside Europe, the core of System, and (3) the contribution to the implementation of the first global international order. The first and third impacts were achieved through the fourth systemic war (the Second World War, 1939-1945), which qualifies as a phase transition because of these two impacts. The first and third impacts, respectively the implementation of dedicated hierarchies (in the core of the System) and the contribution of the singularity dynamic to the implementation of the first global order (at a global scale), are the outcomes of a long-term process of social integration and expansion (SIE), that still is unfolding.

The implementation of the global order also involved energy transfers; five phases can be distinguished. Each phase can be associated with a fundamental change in energy transfers; see below table.

Further analysis of the war data reveals that the pace of the expansion of the core accelerated with the same rate as the integration of its core.

I determined the accelerating rate of expansion of the core, by determining which wars in Levy's dataset (38) correspond with the start of the five phases of the expansion process; see table 50.

The rate of integration of the core is determined by the acceleration of the cycles that accompanied the finite-time singularity dynamic (1495-1945).

As below figure shows, the acceleration rates of the process of integration and expansion are about the same.

Five phases of expansion from a European to a global System

Phase	Timing	Characteristics	Triggers
(I) Core formation and integration: Initially (1495-1812): 'Internal core dynamics only'	Starting 1495	During the period 1495-1812 all Great Power war dynamics still take place within Europe, the core of the System.	During the period 1495-1812; internal core dynamics only.
(II) Core expansion: 'Power projection outside Europe'	Starting 1812	European Great Powers become involved in or start wars outside of Europe.	The War of 1812, 1812-1814, war 88 in Levy's data-set marks the beginning of this phase. Other wars that are part of phase two are 97, 99, 104, 105, 110, and 112 (38).
(III) Non-core involvement in European affairs	Starting 1914	Non-European Great Powers become involved in European war dynamics.	The United States' and Japan's involvement in the First World War (1914-1918) mark the beginning of this phase.
(IV) Non-European powers autonomously produce their own war dynamics	Starting 1931	Non-European Great Powers initiate their own Great Power wars outside of Europe, without the direct involvement of European Great Powers.	The Manchurian War (109, involving Japan and China) marks the beginning of this phase.
(V) Globalization of the System and merging of core and non-core	Starting 1941	War dynamics become connected on a global scale.	Japan attacks the United States (Pearl Harbor, 1941), and Germany (ally of Japan), declares war on the United States, connecting war clusters in Europe and Asia.

Table 50 *This table shows the five expansion-phases of the System that can be determined during the unfolding of the finite-time singularity dynamic (1495-1945). The start of each phase correspondents with a specific war, as explained in the column 'triggers'.*

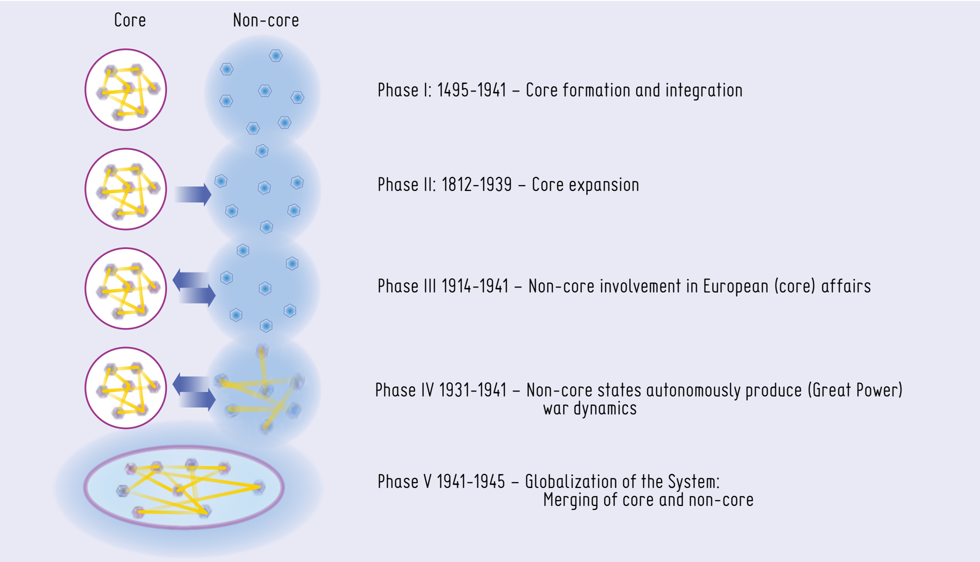


Figure 61 *This figure shows the energy transfers during respective phases that can be observed during the process of expansion.*

Cycles and phases related to the process of integration and expansion (SIE) of the anarchistic System (1495-1945)				
		Integration T(c) = 1939		Expansion T(c) = 1941
Cycle/Phase	Start T	T(c) - T	Start T	T(c) - T
1	1495	444	1495	446
2	1648	291	1822	129
3	1815	124	1914	27
4	1918	21	1931	10

Table 51 *In this table I show how I determined the duration of successive (integration) cycles and expansion phases. The critical time (T(c)) for the process of integration is the timing of the anarchistic System's collapse in 1939; The critical time for the process of expansion is 1941, when the System 'globalized' through the global linkage of war and issue clusters.*

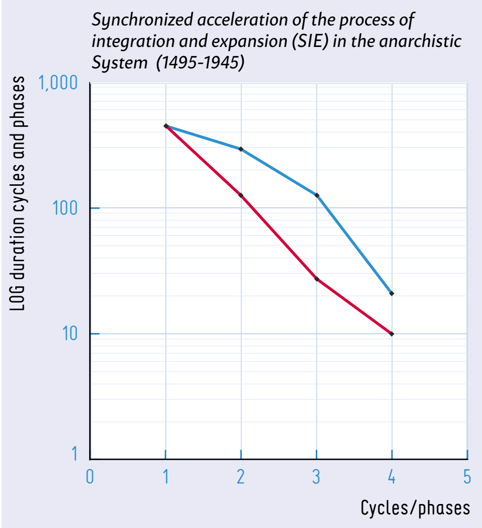


Figure 62
This figure shows the acceleration of the processes of integration (blue) and expansion (orange) in the anarchistic System. The data points related to the process of integration (blue) depict the life-spans of successive cycles (that can be considered 'phases of integration' in the core). The data points related to the process of expansion (orange) depict the duration of the four phases that can be distinguished in the process of expansion of the core to the non-core. The figure shows that both processes accelerated at about the same rate. It not only confirms the close relationship between both processes, and was to be expected given the fact that both processes originated in the core of the System (Europe), and that the pace of these processes is determined by the level of connectivity of the core, itself a function of its population size. Population growth, in other words, set the pace for integration, as well as expansion in the System. The correlation coefficient of the series is 0,92.

This is of course not a coincidence: both rates of acceleration – integration and expansion – are determined by the connectivity of the core (Europe) of the System. Connectivity is the driver of both – closely related – processes. Connectivity is a function of population size of the System, and sets its pace of life.

The same moment as the process of integration reached 'infinity', and the finite-time singularity dynamic produced cycles at an infinite frequency (1939, when the System reached the critical connectivity threshold), the process of expansion was also 'complete', in the sense that the first global order was implemented that formally marks the globalization of the System.

11 The System depicted as an interacting system of a deterministic and contingent domains, and accompanying variables

11.1 The System depicted as an interacting system of deterministic and contingent domains and variables

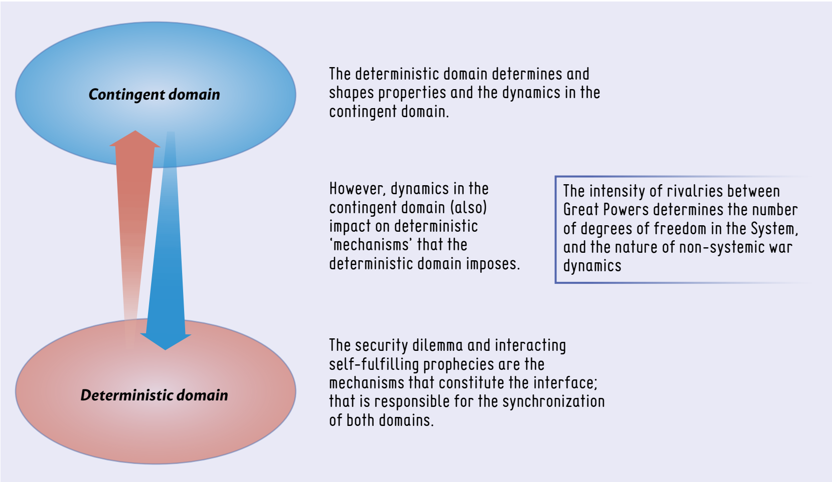


Figure 63 *This figure shows the contingent and deterministic domains of the System, which are connected through an 'interface'. The security dilemma and interacting self-fulfilling prophecies are the two mechanisms that constitute the interface.*

11.2 Explanation of the 'domain model'

It is possible to analytically distinguish between two 'domains' that together determine the dynamics and development of the System: respectively a deterministic and a contingent domain. Until now the 'underlying' deterministic domain was not identified; we were not aware of its existence, let alone of its deterministic – and decisive – impact on dynamics in and between social systems, and on what we depict as historical processes.

This study shows that the deterministic domain determined and shaped the dynamics and development of the System. The second law of thermodynamics and its accompanying principles, the singularity dynamic, non-systemic war dynamics, and connectivity effects are all parts – components – of the deterministic domain. The deterministic domain determines when energy will be released, that is, when wars start, their duration, their sizes, and their intensities and severities. The deterministic domain determines the critical connectivity threshold and, given the growth rate of the connectivity of the System, and the timing of when the System will experience an unavoidable phase transition.

How wars are fought (for example, with what technologies), why wars are fought, and what states will form alliances to fight each other are determined in the contingent domain of the System and by contingent variables. Laws that apply to the System determine that new dedicated hierarchies must be implemented at certain points (in Europe, 1939-1945), to ensure that the System and its dynamics comply with the second law of thermodynamics. The exact structure of the hierarchies and their political organization are contingent variables. The Western hierarchy that was introduced following the phase transition (1939-1945), was based on democratic and capitalist principles, whereas the Eastern hierarchy was authoritative in nature, and applied centralized economic planning principles. From the perspective of the second law of thermodynamics however, these contingent 'details' are not relevant; the point is that both orders reduced the energy state of the System, in compliance with the second law of thermodynamics.

In statement 229 I discuss some alternative scenarios regarding potential directions of development of the System following the phase transition (1939-1945) that also complied with the deterministic and contingent demands of both domains.

Both domains, of course, interact and together represent the System and its singularity dynamic. The abnormal war dynamics of the System during both exceptional periods (1657-1763 and 1953-1989) for example show how contingent developments - intense rivalries between respectively Britain and France, and the United States and the Soviet Union, determined the number of degrees of freedom in the System, and by doing so determined the nature of the non-systemic war dynamics.

From an analytical point of view, 'coordination' between the deterministic and contingent domains of the System is accomplished through interacting self-fulfilling prophecies between states and the security dilemma. These mechanisms are responsible for the production, storage, and deployment of free energy and tensions in respectively the deterministic and contingent domain of the System; free energy and tensions are equivalent.

I consider interacting self-fulfilling prophecies for that reason the interface between both domains: interacting self-fulfilling prophecies determine how the free energy that is produced crystallizes in underlying vulnerable issue clusters, and what meaning and justification states and populations give to energy releases – wars – the anarchistic System produces to comply with the second law of thermodynamics.

12 The dynamic System depicted as a change model (levels and mechanisms of change)

12.1 The System depicted as a change model.

Levels and mechanisms of change		
Level	Change	Mechanism
1	Change in the nature of the System from anarchistic to non-anarchistic.	Through the implementation of dedicated hierarchies in the core of the System (Europe) through a phase transition (the fourth systemic war, the Second World War, 1939-1945). This level of change was accomplished (in the contingent domain) by implementing the next level of SIE.
2	Change in the order of the System, without changing its basic (anarchistic/non-anarchistic) nature.	Through the implementation of new arrangements (upgraded international orders) through systemic wars.
3	Change in the nature of non-systemic war dynamics.	Through a change in the number of degrees of freedom in the System: $n > 2$ implies chaotic dynamics, $n = 2$ implies periodic dynamics. The intensity of rivalries between states determines the number of degrees of freedom in the System.
4	Change in the relationship of the System with its environment.	Through expansion of the System outside its core.

Table 52 *This table shows the levels of change and corresponding mechanisms that can be distinguished in the System during the 1495-1945 period.*

12.2 Explanation of the change model

It is possible to distinguish three levels and mechanisms of change *in* the System, and one level and mechanism of change of regarding the System's relationship with its environment.

1 ***Level 1 change: A change in the nature of the System from anarchistic to non-anarchistic***

A change in the fundamental nature of the System, from anarchistic to non-anarchistic and vice versa, was (and is) the most fundamental change the System could (and can) experience. Such a fundamental change was accomplished through the implementation of dedicated hierarchies in the core of the System (Europe). These dedicated hierarchies neutralized anarchy and the security dilemma, and stopped the production of tensions and free energy within respective hierarchies.

Level 1 change was accomplished through the finite-time singularity dynamic accompanied by four cycles (1495-1945), which constituted a step-by-step process of increasing order in the deterministic domain, and a parallel and synchronized process of integration in the contingent domain of the System. The dynamics in both domains were determined and shaped by the second law of thermodynamics.

The ultimate implementation of dedicated hierarchies – non-anarchistic clusters of states – in the core of the System (Europe), constituted a phase transition. The three preceding cycles – relatively stable periods and accompanying systemic wars – can be considered precursory dynamics that announced this eventual and necessary phase transition in the System.

In the contingent domain of the System, level 1 change manifested itself through the implementation of the next level of social integration and expansion (SIE) in its core. This was a final step in a much longer SIE process, that started when the first humans and their tribes, 'integrated' into larger units to be able to better – collectively – fulfill their basic requirements and enhance their survival changes.

The finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period is mere a specific phase in this long-term process. During this period (1495-1945) a sizeable collection of divers and loosely connected units in Europe (1495) transformed through the finite-time singularity dynamic into a highly integrated system of a relatively small number of highly standardized states with a fractal size distribution (1939), before ultimately transforming into two non-anarchistic dedicated hierarchies (1945). To achieve this, during the unfolding of the singularity dynamic the units of the System evolved into 'organizations' that were increasingly specialized in producing and deploying destructive energy; without this development the singularity dynamic could not have unfolded and achieved its ultimate purpose.

A reversed change, of a non-anarchistic social system (a state or dedicated hierarchy, including the European Union) to an anarchistic condition, also qualifies as a level 1 change. Such a fundamental change is the outcome of a process of social fragmentation; the reverse of the SIE process. Integration and fragmentation are continuously competing forces.

Initially the System produced two dedicated hierarchies through the phase transition (1939-1945); a Western hierarchy dominated by the United States, and an Eastern hierarchy dominated by the Soviet Union. As a consequence of internal unbalances that undermined the ability of the Soviet Union and Eastern hierarchy to ensure the balanced fulfillment of its basic requirements, that were further reinforced through the intense rivalry with the Western hierarchy, the Eastern hierarchy collapsed in 1989. This fragmentation process – the undoing of the SIE implemented by the phase transition in Eastern Europe – was followed by the integration of fragments of the Eastern hierarchy into the Western hierarchy.

In 1989, the Western hierarchy, which had been following a fundamentally different integration logic since its inception, had built up enough integrative capabilities in the contingent domain to integrate these fragments.

Through the high degree of connectivity of Europe, including the Eastern European states, and the local stabilities this implied, the 'European System' was too highly connected to produce non-systemic wars; these conditions of the deterministic domain enabled peaceful integration in the contingent domain. However, as current dynamics and developments in Europe (also) show, SIE – and a certain state of integration – cannot be taken for granted: Further developing and maintaining a certain level of integration – structural stability in a non-equilibrium system – require a constant input of energy to achieve this. If the fabric of such a system does or cannot accomplish this, or cannot efficiently transform the input of energy in supportive structures, fragmentation becomes unavoidable: the second law of thermodynamics will see to that.

2 ***Level 2 change: A change in the order of the System, without changing its basic (anarchistic/non-anarchistic) nature***

Level 2 change is less fundamental and preceded level 1 change. During the life span of the singularity dynamic (1495-1945), the System experienced level 2 change three times through three systemic wars (1618-1648, 1792-1815, and 1914-1918). New upgraded orders were periodically implemented without changing the anarchistic nature of the System. Through these upgraded orders the System lowered its energy state and ensure compliance with the requirements of the second law of thermodynamics.

Level 2 change was sufficient, as long as the upgraded orders that were implemented could deal with the increasing amounts of free energy (tensions) that were produced as a consequence of the intrinsic incompatibility between connectivity and security in the anarchistic System. In 1939, when the System reached the critical connectivity threshold and the degree of incompatibility in the anarchistic System reached infinity, level 1 change, a phase transition towards non-anarchistic structures to contain the production of free energy, became unavoidable.

3 ***Level 3 change: Change in the nature of non-systemic war dynamics***

Level 3 change does not imply a change in the structure of the System, but in the nature of its non-systemic war dynamics. A decrease in the number of degrees of freedom of the System, accomplished through the degree of rivalry between states in the System, from $n > 2$ to $n = 2$ caused the System to bifurcate from chaotic to periodic war dynamics (in 1657), and vice versa (1763). An (almost) similar change can be observed in 1953 and 1989 (defining the second exceptional period).

Level 3 change (as it manifested itself during the first exceptional period, 1657-1763) also implies a change in the predictability of non-systemic wars, from intrinsically unpredictable (chaotic) to more regular (periodic), and a change in the severities of non-systemic wars, from constrained (chaotic) to extreme all-or-nothing (periodic).

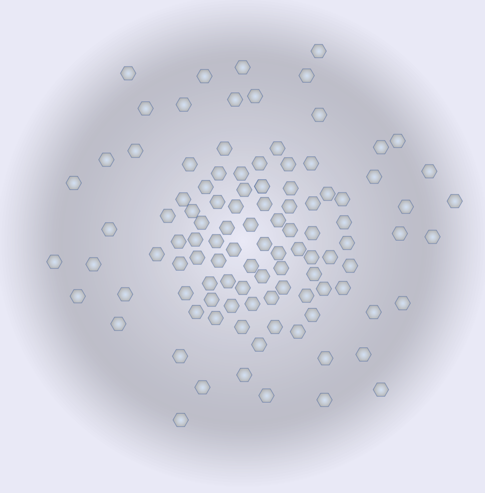
4 ***Level 4 change: A change in the relationship of the System with its environment***

Expansion of the System from its European core to the non-core of the System (1495-1945) was a gradual process. In this process I distinguish five phases, based on the 'nature' of the war dynamics (expansion wars) of the System. The expansion started with the awareness that a non-core existed (discoveries of other territories) that could be used or exploited to contribute to the fulfillment of basic requirements of states constituting the core. This led to a process of expansion in which European states acquired political control outside the core that led to interdependencies between the core and non-core. Eventually the non-core developed its own dynamics, including the 'autonomous' production of tensions and wars (not directly related to the dynamics of the core). The second law of thermodynamics of course also applied to the dynamics outside the core of the System. It was just a matter of time, before the second law of thermodynamics would demand 'order' at a global level (including the non-core) to allow for a lower energy state at a global scale of the (now) global System.

The fourth systemic war (the Second World War, 1939-1945) for that reason not only constituted a phase transition in the European core, but also marked the globalization of the System by implementing the first global international order, a development that also qualifies as a phase transition. Both developments, including both phase transitions, constitute coevolving dynamics; both phase transitions are necessarily linked.

13 The finite-time singularity depicted as a distinct phase in a long-term process of social integration and integration (SIE)

13.1 The System depicted as a step in a long-term SIE process



Phase 0, < 1495: Pre-System

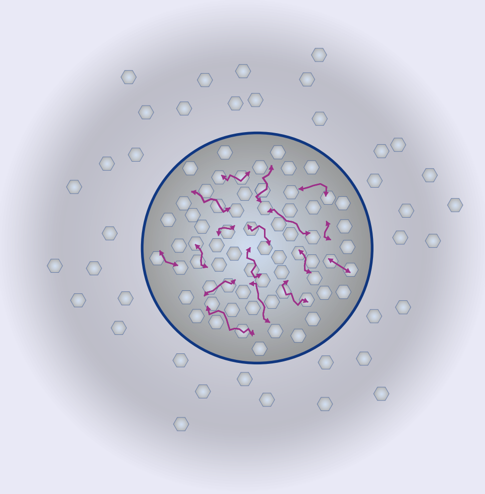
~ Before 1495 the 'system' - including its core - was insufficiently connected to develop coherent system-behavior

~ The 'system' reached the percolation threshold in 1495

~ In 1495, 'Europe' (the core of the System) consisted of 200-300 diverse and loosely connected 'units'

~ In 1495, the population size of the core of the System was circa 83 million

Figure 64 *Phase 'o' SIE.*



Phase I, Start 1495: Core-formation and integration

~ Starting in 1495 a finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) unfolded in the System

~ The System became critical for the first time in 1618

~ By means of systemic wars free energy (tensions) was put to work to implement upgraded orders

~ Population growth powered the finite-time singularity dynamic, and vice versa

~ The number of units in the System decreased, and (increasingly) crystallize in fractal structures

Figure 65 *Phase I SIE.*

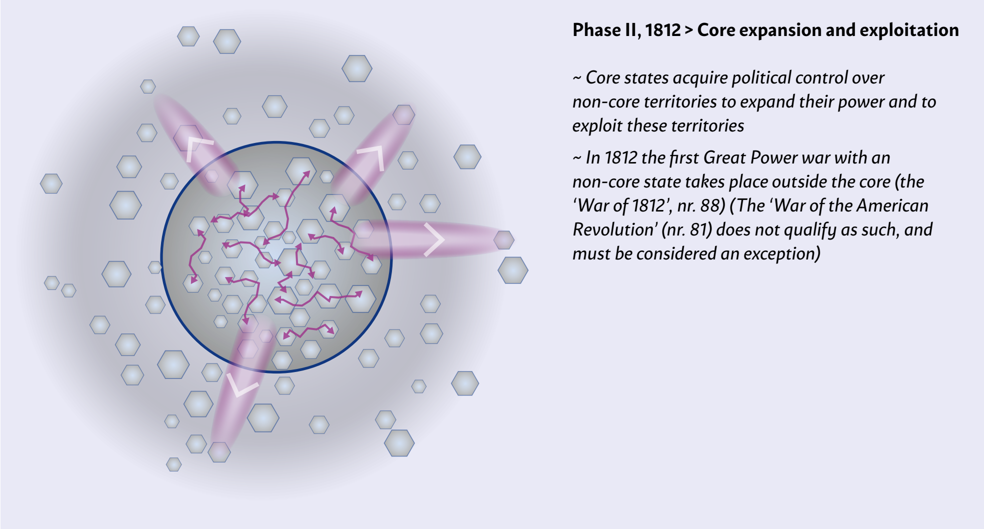


Figure 66 *Phase II SIE.*

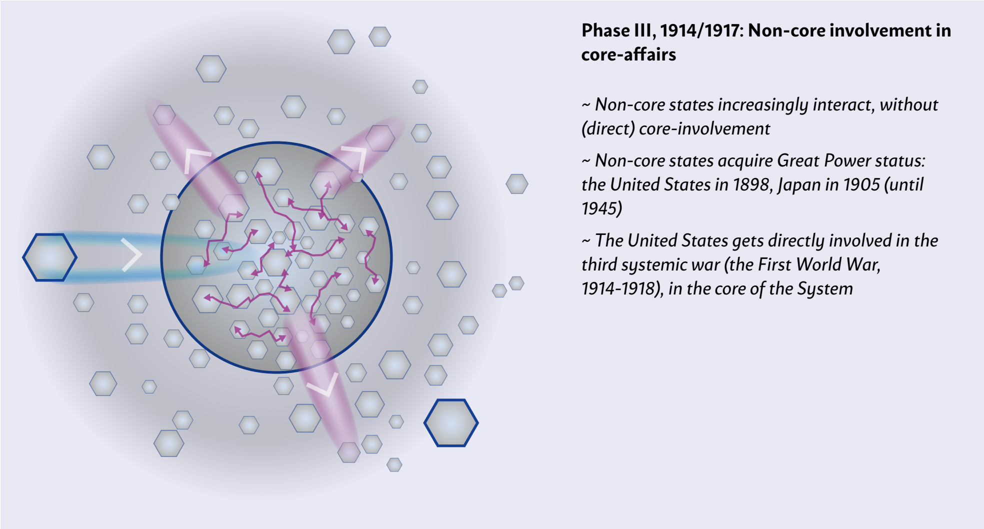


Figure 67 *Phase III SIE.*

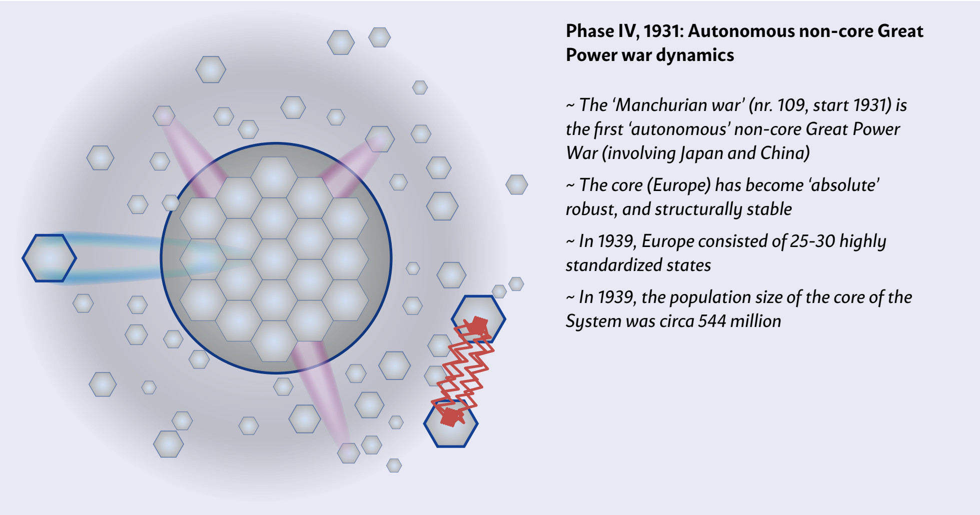


Figure 68 *Phase IV SIE.*

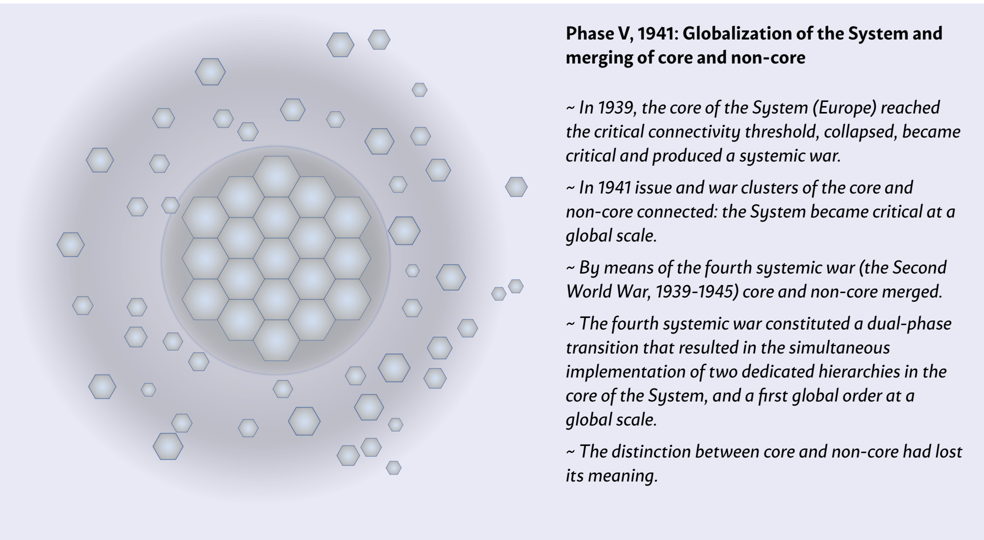


Figure 69 *Phase V SIE.*

13.2 Explanation of the SIE model

The SIE model is closely related to the energy transfer model that describes the same process from a somewhat different perspective. The SIE process can be depicted as a crystallization process. It started millennia ago when families and tribes started cooperating to ensure the fulfillment of their basic requirements. Cooperation allowed for the development and exploitation economies of scope and scale. This process is still ongoing; the finite-time singularity dynamic the System developed during the 1495-1945 period, causing the integration of Europe and the expansion of the System to a global scale, is just a phase in the long-term SIE process.

In this particular period of SIE (1495-1945), I distinguish five phases:

1 ***Phase I: Core formation and integration***

During the formation and consolidation of the core in Europe, humans and social systems clustered into units and states. These clusters had to become stable to avoid collapse. Depending on various conditions, states have a minimum critical size. The development of the sizes of states in the System shows that the minimal critical size of units (states) increased over time. Size and survival (avoiding internal collapse and external take-over) are related properties. The development of the core of the System during the 1495-1945 period, from a large number of loosely connected and highly divers units, to a highly integrated system of highly standardized states, also shows that the size distribution of states could eventually (shortly before the anarchistic System's collapse in 1939) be best described with a power law. The fractal structure of the System is highly optimized, and ensures that the (unavoidable) production of tensions (free energy) in the anarchistic System was minimized, while at the same time enabling the optimal distribution of destructive energy during systemic wars to upgrade orders of anarchistic System to a next level, consistent with the demands of the second law of thermodynamics.

Through a combination of conditions in the core of the anarchistic System, including: the production of free energy, the intensities of interactions between units (states) in the System, the structure of networks they formed, and physical laws (such as the second law of thermodynamics) that apply to these dynamics - the System produced a highly regular self-organized finite-time singularity dynamic accompanied by four accelerating cycles; Consistent with the demands of the second law of thermodynamics, the accelerating cycles produced increasing levels of internal order.

In fact, the singularity dynamic 'fed on itself', and 'harbored' a self-reinforcing mechanism: the singularity dynamic – powered by free energy produced by the increasing connectivity of the System – enabled again-and-again (four times), further connectivity growth during relatively stable periods; the increasing amounts of free energy that was produced during these successive relatively stable periods were then put to work at an accelerating rate, to ensure compliance with the demands of the second law of thermodynamics. This process could continue at an accelerated rate until the anarchistic System reached the critical connectivity threshold (the singularity in finite time), then as a consequence produced infinite amounts of free energy (tensions), and collapsed as a consequence. A dual-phase transition was the ultimate outcome of this particular phase of SIE in the System.

Through the singularity dynamic and the interactions between states that underlay it, uneven states (states with different interests and power) could fulfill their basic requirements in an anarchistic System, ensuring their (collective) survival.

The singularity dynamic also ensured the evolvability of the System: its ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars, to ensure 'sufficient' performance of the System (during relatively stable periods).

2 *Phase II: Core expansion and exploitation*

States have to fulfill basic requirements to ensure their survival. In their quest for resources, states also expanded outside the core (Europe) and established political control in territories in the non-core. The expansion of the core to the non-core can be considered an extension of European dynamics. Both control, and the dynamics and tensions between states in the core of the System, were extended or exported. It was a matter of time before states of the core (Europe) established similar state-like structures outside the core, to effectuate their control and ensure maximal exploitation.

Because of the overflow of tensions from the core to the non-core and the contribution of non-core exploitation to power positions and influence of states in the core, the non-core increasingly became connected to the core. Starting in 1812 (with the 'War of 1812'), states deployed destructive energy in response to local tensions outside the core.

3 *Phase III: Non-core involvement in core-affairs*

It was also a matter of time before state-like structures outside the core started to develop their own autonomous (intra non-core) dynamics and interests. This could cause tensions with the core-state that controlled them (in some cases leading to independence as for the United States in 1776), but also caused tensions between units clusters in the non-core. From a crystallization perspective, during phase III the non-core developed increasingly autonomous nucleation and cluster growth.

It was just a matter of time before states in the non-core of the System achieved Great Power status (the United States in 1898, Japan in 1905 and China in 1949, (38). Because of their increasing interdependence with core states, these Great Powers became involved in what used to be internal core dynamics, and had an increasing interest in the upgraded orders that systemic wars – the singularity dynamic – in the core could produce. These dynamics and developments caused the United States, a non-core Great Power, to get involved in the third systemic war (The First World War, 1914-1918) in the core of the System, to ensure the implementation of a favorable upgraded international order, that would also serve the interests of the United States.

From this perspective the First World War (the third systemic war, 1914-1918) was – contrary to the Second World War (the fourth systemic war, 1939-1945) – not a ‘world war’, but still an European war; the System was not yet globalized at that stage. The First World War constituted an intermediate war, and was a manifestation of the intermediate stage of development of the System at that stage; from a European to a global System.

4 ***Phase IV: Autonomous non-core Great Power war dynamics***
The Manchurian War (war nr. 109, involving Japan and China) marks the beginning of this phase. The Manchurian War is indicative for the autonomous dynamics in the non-core.

However, despite the development of autonomous intra non-core dynamics, the core and the non-core were intimately connected. European states controlled increasingly large amounts of non-core territory, leading to the implementation of an increasing number of state-like structures. “European states held political control over about 7 percent of the earth’s land in 1500, 35 percent in 1800, and 84 percent in 1914” (70) From network and energy-transfer perspectives, this implies increasing connectivity in number and intensity of core and non-core connections, and increasing energy transfers between core and non-core.

5 ***Phase V: Globalization of the System and merging of core and non-core***
The order that was implemented by means of the third systemic war (the First World War, 1914-1918) addressed, or tried to address, free energy and tensions in the core and non-core of the (already) extended System. However, the League of Nations, the order that was implemented to ensure a lower energy state in the extended System, was not effective in restraining tensions. The third order did not solve the incompatibility between increasing connectivity and anarchy, and increasing connectivity still produced free energy and tensions at an accelerating rate: No order in the (by then highly connected) anarchistic System, would have been able to prevent the production of ultimately infinite tensions and its eventual collapse in 1939.

It seems that this particular order – the League of Nations – in the contingent domain of the System, provided (so to say) insufficient order in the core of the System, and too much order (at that stage) outside of the core (Europe); both shortcomings contributed to its (already) limited legitimacy.

However, whatever the shortcomings of the League of Nations were, any order that would (or could) have been implemented following the third systemic war (the First World war, 1914-1918), would not have been able to deal with infinite tensions that would be produced by the anarchistic System: any order was doomed to fail. Collapse was unavoidable for whatever order, when the anarchistic System in 1939 reached the critical connectivity threshold, and as a consequence produced infinite amounts of tensions (free energy).

The core of the System became critical in 1939, and the System produced a systemic war in Europe to re-establish order (to meet the demands of the second law of thermodynamics). In 1941, the vulnerable issues- and war clusters that had formed in the core, and issues and wars that that were produced autonomously in the none-core (in Asia), connected, and the System now became critical at a global scale, producing the first systemic war with a global reach. Because the System became critical at a global scale and involved all Great Powers, a global international order was designed and implemented that contained a specific solution (necessary to meet the demands of the second law of thermodynamics) for the non-core: the implementation of dedicated hierarchies in Europe.

Through the fourth systemic war (The Second World War, 1939-1945), the dysfunctional third order was destroyed, and a global order was designed and implemented. The second law of thermodynamics ensured that both interdependent orders, the first global order and the upgraded European order, were consistent and 'merged'. Through these developments – the process of merging – the distinction between core and non-core lost its original meaning.

The SIE process, powered by population growth and the rivalry between states (and other clusters that populations form), did not stop here. In the current (now global) System, that is anarchistic at a global scale, connectivity (interdependence) and security still are intrinsically incompatible. Increasing connectivity of the (now) global anarchistic System – of which population growth is the main driver – still results in the production of increasing amounts of free energy (tensions); it is just a matter of time, before the second law of thermodynamics will put the free energy to work – through a systemic war – to establish an upgraded order that (again) enables a lower energy state in the System.

Accelerating expansion of the System (1495-1941)		
Phase	Start date	Time to globalization (1941 - start date)
(I) Core formation and integration	1495	446
(II) Core expansion	1812	129
(III) Autonomous non-core formation and involvement in European affairs	1914	27
(IV) Non-European powers autonomously produce their own war dynamics	1931	10
(V) Globalization of the System and merging of core and non-core	1941	0

Table 53 *This table shows the accelerating expansion of the System (1495-1941).*

13.3 Synchronization and interaction

During the 1495-1945 period, the SIE process, developed very regularly:

1 ***Synchronization and mutual reinforcement of the integration and expansion of the System (1495-1945)***

The process of integration of the core (Europe), through successive upgrades of its order, and the expansion of the core to the non-core, and the development of autonomous non-core dynamics, accelerated with the same rate. I assume that the processes of integration and expansion reinforced each other.

Cycles and phases related to the process of integration and expansion (SIE) of the anarchistic System (1495-1945)

		Integration T(c) = 1939		Expansion T(c) = 1941
Cycle/Phase	Start T	T(c) - T	Start T	T(c) - T
1	1495	444	1495	446
2	1648	291	1822	129
3	1815	124	1914	27
4	1918	21	1931	10

Table 54 *In this table I show how I determined the duration of successive (integration) cycles and expansion phases. The critical time (T(c)) for the process of integration is the timing of the anarchistic System's collapse in 1939; The critical time for the process of expansion is 1941, when the System 'globalized' through the global linkage of war and issue clusters.*

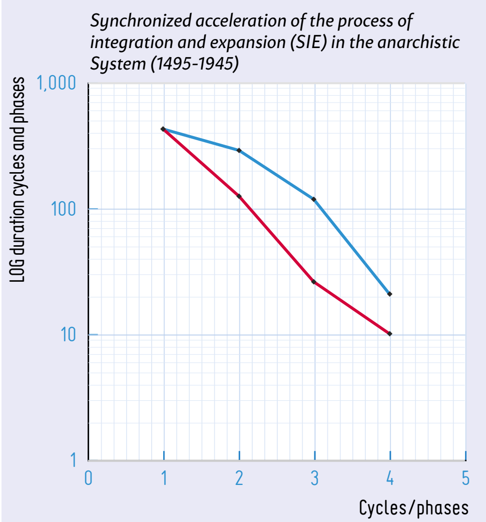


Figure 70
This figure shows the acceleration of the processes of integration (blue) and expansion (red) in the anarchistic System. The data points concerning the process of integration (blue) concern the life-spans of successive cycles (that can be considered 'phases of integration' in the core). The data points concerning the process of expansion (orange) represent the duration of the four phases that can be distinguished in the process of expansion of the core. The figure shows that both processes accelerated at about the same rate. It not only confirms the close relationship between both processes, but was also to be expected, given the fact that both processes originated in the core of the System (Europe), and that the pace of these processes is determined by the level of connectivity of the core, itself a function of its population size. Population growth, in other words, set the pace for integration, as well as expansion in the System. The correlation coefficient of the time series is 0,92.

2 ***Acceleration of the fraction of expansion wars during successive cycles of the first finite-time singularity dynamic***

During successive cycles of the first finite-time singularity dynamic (1495-1945) the System produced respectively 45 - 34 - 21 - 6 non-systemic wars (total 106). Respectively 0 - 1 - 4 - 4 of these wars qualify as expansion wars.

During successive cycles of the first finite-time singularity dynamic, the fraction of expansion wars increased exponentially.

The correlation coefficient of the number of wars during successive cycles, and the fraction of expansion wars is - 0,93.

Expansion wars: Fraction of non-systemic wars (1495-1945)			
Cycle	Non-systemic wars (total)	Expansion wars	Fraction (Expansion wars)
1	45	0	0
2	34	1	0.029
3	21	4	0.190
4	6	4	0.667

Table 55 *This table shows the fraction of expansions wars during successive cycles of the first singularity dynamic (1495-1945).*

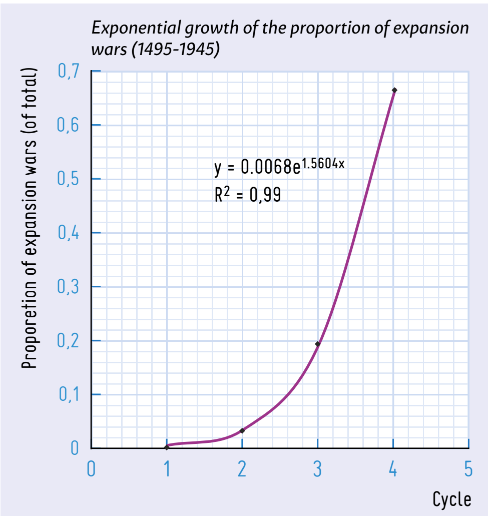


Figure 71
This figure shows the exponential growth of the proportion of expansion wars during successive cycles of the first finite-time singularity dynamic (1495-1945).

I argue that the growth rate of the fraction of expansion wars is related to the increasing robustness of successive cycles of the first finite-time singularity dynamic, and the accelerating expansion of the System. I assume that the increasing connectivity (population growth) of the System is the 'driver' of these dynamics.

13.4 Lynchpins

So-called 'lynchpins' were instrumental in the synchronization of the process of integration and expansion in the System, during the 1495-1945 period.

During the process of integration, political control of core states (European states) over non-core territories (I refer to their colonies, and related interests), ensured synchronization and interaction; during the process of integration, core-states acted as lynchpins.

As a consequence of the re-alignment of the System through the fourth systemic war (the Second World War, 1939-1945), that constituted a dual-phase transition, the System simultaneously implemented two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a first global order at a global scale of the System. Both orders were complementary, and the two dedicated non-anarchistic hierarchies became integral components of the global order. The integration of the 'European order' in the global order, was accomplished through the United States and the Soviet Union, which respectively controlled the Western and Eastern hierarchy, and also had established themselves as 'Superpowers' with a global reach: The United States and the Soviet Union now acted as the lynchpins of the System, ensuring 'synchronization' of both orders. See figures: 24, 25 and 26.

14 The first international order of the System depicted as a damped oscillator

14.1 The first international order of the System depicted as a damped oscillator

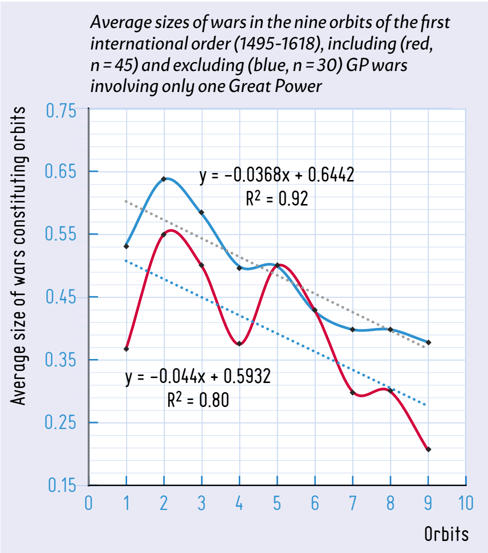


Figure 72
This figure shows the properties of the nine orbits the anarchistic System produced during the first relatively stable period (the first international order, 1495-1618). The properties developed very regularly: The orbits – the war dynamics during the first international order – constitute a damped oscillator. In the red plot Great Power wars with one Great Power are included (n = 45); in blue Great Power wars only involving one Great Power are excluded (n = 30).

14.2 Explanation of the workings of the damped oscillator

Non-systemic wars during international orders (during relatively stable periods of cycles, that precede systemic wars) are instrumental in maintaining a certain functional balance.

During the first international order (1495-1618) the anarchistic System produced 45 non-systemic wars. Analysis of these non-systemic wars shows that these 45 non-systemic wars made up nine circular trajectories – orbits – in phase state (defined by size and intensity). The average size of wars constituting respective orbits developed very regularly, and in fact made up a damped oscillator.

As Sterman explains: "In an oscillatory system, the state of the system constantly overshoots its goal or equilibrium state, reverses, then undershoots, and so on. The overshooting arises from the presence of time delays in the negative loop. The time delays cause corrective actions to continue even after the state of the system reaches its goal, forcing the system to adjust too much, and triggering a new correction in the opposite direction" (69). Different types of oscillations can be distinguished, including 'damped' oscillations. The equilibrium of a damped oscillator is said to be locally stable. "Perturbations will cause the system to oscillate, but it will eventually return to the same equilibrium... While many oscillatory systems are damped, the equilibriums of other systems are locally unstable, meaning that small disturbances tend to move the system farther away from the equilibrium point" (69).

The amplitude of successive oscillations (orbits) - corrections by the System – decreased regularly: Shortly before the 'collapse' of the international order – shortly before the System became critical in 1618 and produced a systemic war (the first systemic war, the Thirty Years' War, 1618-1648) - the first international order reached its equilibrium state.

The dampening effect is however misleading: although the international order eventually reached the equilibrium state, the tensions (free energy) the System produced, increased at the same time. I attribute the 'dampening' of oscillations to the connectivity/local stability effect.

15 The System depicted as a set of early warning signals

15.1 The System depicted as a coherent set of early warning signals

With the help of regularities in the dynamics and development of the anarchistic System during the 1495-1945 period – the period when the first finite-time singularity dynamic accompanied by four accelerating cycles unfolded – a number of deterministic and contingent indicators can be identified that could provide clues for the assessment and prediction of the dynamics and developments of the current order.

1 *Deterministic indicators*

The following deterministic indicators can be identified:

	Deterministic indicators for assessment and prediction	
	Indicator	Clarification
1	Rate of population growth.	Determines the free energy that will be produced in the System and its connectivity.
2	The number of degrees of freedom of the System.	Determines whether non-systemic war dynamics are chaotic or non-chaotic. Chaos is a precondition for the System to form underlying vulnerable issue clusters and to become critical.
3	Average size of non-systemic energy-releasing wars.	Determines if the System is in a low- or high-connectivity regime.
4	Development of the frequency of non-systemic energy releases.	Determines if the System is in a low- or high-connectivity regime.
5	Changes in centrality of nodes (development of Great Power status dynamics).	Indicator for the structural stability – organizational permanence – of the System.
6	Changes in the size and form of nodes (states).	Indicator for the structural stability – permanence of political control – in the System.
7	The nature of the size distribution of states in the System; the level of fractality of the System.	Indicator for the performance of the System, and the efficiency of free energy production and (re-)distribution in the System.
8	Robustness of the System.	Determines the System's sensitivity to perturbations and its ability to release free energy through non-systemic release events. This property is closely related to the System's fragility.
9	Fragility of the System.	Determines the life span of relatively stable periods. This property is closely related to the System's robustness.
10	The durations of relatively stable periods and of critical periods (respectively the life span of international orders and systemic wars).	Indicator for the connectivity and pace of life of the System. Decreasing durations mean the System is approaching the critical connectivity threshold.

Deterministic indicators for assessment and prediction		
11	Amount of destructive energy that is deployed during critical periods, for which severities of systemic wars is an indicator.	Indicator for the connectivity and pace of life of the System. Increasingly higher – and ultimately infinite – amounts of destructive energy means the System is approaching the critical connectivity threshold.
12	The rate of acceleration of the System.	Indicator for the connectivity and pace of life of the System. Increasing and ultimately infinite acceleration means the System is approaching the critical connectivity threshold.

Table 56 *This table shows deterministic indicators.*

2 *Contingent indicators*

The following contingent indicators can be identified:

Contingent indicators for assessment and prediction		
	Indicator	Clarification
1	Development of the power flux (CINC-index).	The development of the CINC-indices indicates whether states produce destructive energy.
2	Development of alliance dynamics.	The development of alliance dynamics indicates whether states are concerned with their security and try to hedge risks.
3	Development of tensions in the System.	Tensions are manifestations of free energy, and are transformed into destructive energy.
4	The number of issues in the System and their interconnectedness.	The number of issues is indicative of the war potential of the System.
5	The number and nature of unresolved issues and their interconnectedness.	The number and nature of unresolved issues are indicative of the buildup of underlying vulnerable issue clusters.
6	Ideological reach, outspokenness, and radicalization.	Ideological developments are indicative of the mobilization potential and ultimately war preparedness of states.
7	Perceived unpredictability of wars and their properties.	The perceived unpredictability of wars, including unexpected escalation and unexpected de-escalation and containment, are indicative of the chaotic nature of these dynamics.
8	The willingness of states to get involved in non-systemic wars.	The willingness of states to engage in wars is indicative whether the System is in a low- or high-connectivity regime, and of the chaotic or non-chaotic nature of war dynamics. Chaotic war dynamics cause restraint because of the intrinsic unpredictability of these types of wars.
9	The level of representativeness of the current order.	To what degree the actual centrality of states is reflected in its order determines the level of functionality and legitimacy of the global order. The degree to which the order's rules and institutions are undermined by states with special privileges is indicative of its ability to maintain the status quo.

Table 57 *This table shows contingent indicators.*

15.2 Explanation of the EWS-model

With the help of both sets of indicators the condition of the System can be assessed, and its behavior be predicted.

This study shows that the power flux and alliance dynamics of the System are not useful indicators: both are contingent indicators and have short lead-times.

The structural stability of the System (Great Power status dynamics, and changes in physical structures of states in the anarchistic System), the System's robustness and fragility on the other hand, are very useful indicators, that (at an early stage) provide valuable information about the condition of the System, and its future behavior.

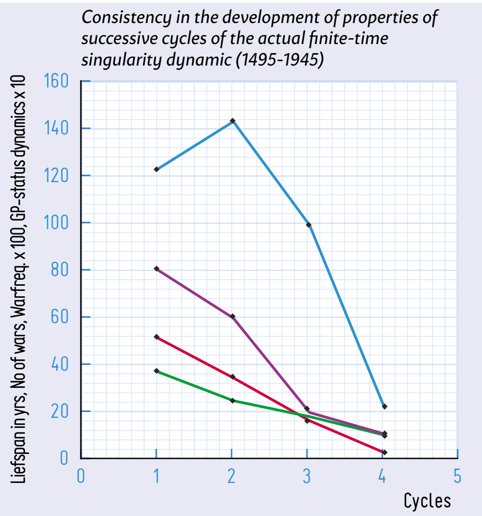


Figure 73
This figure shows (1) the development of the life spans of successive cycles (in blue) of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), indicative for the System's increasing fragility, (2) the development of the structural stability (the number of Great Power status dynamics, in purple) of the System, (3) the development of the absolute number of non-systemic wars the System produced during successive cycles (in red) and (4) of the war frequency (in green) of successive relatively stable periods. During the fourth cycle, shortly before the anarchistic System's collapse in 1939, the fragility, structural stability and robustness of the anarchistic System reached 'absolute' levels. These indicators concern the core of the System (Europe); expansion wars are excluded. Calculations based on data from Levy (38).

This study also shows, that the size development of non-systemic wars during cycles provides accurate information about the proximity of the System to a critical point: Typically – as a consequence of the connectivity/local stability effect during high-connectivity regimes of relatively stable periods – shortly before the System becomes critical and produces a systemic war, the sizes of non-systemic wars decrease to a 'critical fraction'. This study suggests that the critical fraction is in the range of 0.17 - 0.30.

Assuming the war database is correct, the first cycle (1945-...) of the second finite-time singularity dynamic now is in its high-connectivity regime, and will become critical around 2020 when it reaches the critical fraction.

'Critical fractions' of moving averages		
International order		Critical fractions of moving averages of five successive non-systemic wars
1	1495-1618	0.18
2	1648-1792	0.30
3	1815-1914	0.19
4	1918-1939	0.17

Table 58 *This table shows the (critical) values of the moving averages of sizes of five successive non-systemic wars immediately before the System became critical during the first finite-time singularity dynamic.*

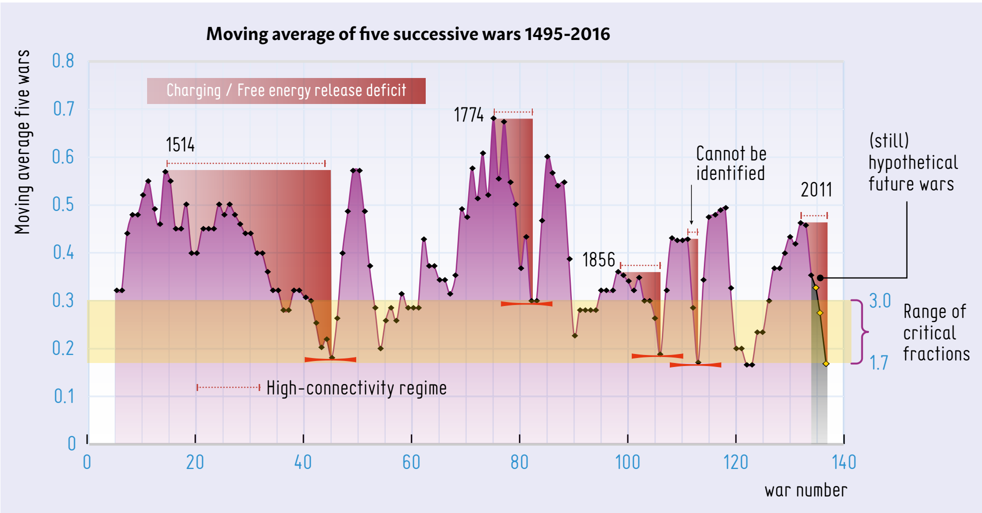


Figure 74 *This figure is an extension of figure 31: Three still hypothetical future wars with a size of one Great Power participating, are now added. This study suggests that the present order (1945-...) reached its tipping point in 2011, and is now in its high-connectivity regime and 'charging' for a next systemic war. It takes about 2-3 non-systemic wars (baseline 2014) for the current order to reach the 'critical fraction-range'. This study suggests that the System will become critical around 2020 and produce a systemic war to implement an upgraded order that allows for a lower energy state (a new relatively stable period) of the System.*

PART III

STATEMENTS

Insanity is contagious

Joseph Heller, Catch-22, 1961

Introduction

In this part I discuss 323 statements; statements address particular issues related to the theory. These statements are grouped in twenty subjects.

Statements, but also the subjects to a degree overlap. In a number of cases, in order to get a better understanding of the functioning of the System, I address a particular subject or issue from different perspectives, that in some cases only differ slightly.

I have grouped the statements in the following twenty subjects:

1 ***Singularity dynamic***

2 ***Systemic and non-systemic wars***

3 ***Intrinsic incompatibility***

4 ***Connectivity and its effects***

5 ***Criticality, self-organized criticality and 'at the edge of chaos'***

6 ***Robustness, fragility and (structural) stability***

7 ***Phase transitions***

8 ***Chaotic and non-chaotic non-systemic war dynamics***

9 ***Non-chaotic non-systemic war dynamics and exceptional periods***

10 ***Properties of war dynamics during specific phases of the first finite-time singularity dynamic (1495-1945)***

Properties of war dynamics during specific phases of the singularity dynamic.

11 ***System performance and evolvability***

12 ***Optimization and fractal structures***

13 ***Free energy and energy transfer***

14 ***Deterministic and contingent domains***

15 ***International orders, the security dilemma and interacting self-fulfilling prophecies***

16 ***Path dependence and lock-in***

17 ***Change***

18 ***Social integration and expansion (SIE)***

19 ***Early warning signals (EWS), prediction, and future developments***

20 ***Implications***

1 SINGULARITY DYNAMIC

027 Physical laws also apply to the System.

KEY WORDS *Physical laws, second law of thermodynamics, Free energy, Upgraded orders, Optimization, Deter ministic System.*

The second law of thermodynamics applies to the System and its dynamics. Two 'principles' related to this law are especially relevant: the principle that 'free energy will be put to work' and the principle of 'least or lowest free energy', meaning that the System will implement an order that enables a lower energy level and minimizes the production of free energy. Free energy in the anarchistic System is produced by the intrinsic incompatibility between connectivity and security in anarchistic systems; the 'basic' driver of the System is its connectivity growth, itself 'powered' by population growth.

I assume that the incompatibility between connectivity and security, as well as the free energy (tensions) the anarchistic System produced (and still produces) as a consequence, increased at an accelerating rate during the unfolding of the finite-time singularity dynamic (1495 - 1945).

The second law of thermodynamics (and accompanying principles) determine and shape the energy transformations that take place in the System; however, other principles and mechanisms also have an impact, including the number of degrees of freedom of the System (determining the nature of non-systemic war dynamics; chaotic or non-chaotic) and the connectivity of the System (determining if the System can build up a free energy release deficit necessary for the emergence of systemic wars as release events). Free energy, and the principles and mechanisms that apply to this energy, produced the finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period.

The second law of thermodynamics and other deterministic 'laws' and properties (just mentioned) determine for example the start date of wars, their duration, how much destructive energy will be released, and for what purpose free energy is put to work (in case of systemic wars, to implement upgraded orders). Furthermore, these laws and principles determine certain design specifications of new orders based on how much order is required to allow for a lower energy state of the System.

The second law of thermodynamics in its continuous 'efforts' to optimize the System' s dynamics and structures in order to meet its demands, also is responsible for the fractal nature of a number of dynamics and structures in the System; fractality of dynamics and structures (including states) contribute to the optimality of energy transformations in the System.

The fact that basic physical laws also apply to the System's dynamics – to social dynamics – was never recognized (always ignored), and explains our limited and misguided understanding of the (war) dynamics and development of the System.

028 A number of conditions must be met for a finite-time singularity dynamic to develop.

KEY WORDS *Singularity dynamic, Conditions, Free energy, second law of thermodynamics, Binary decisions, Local stabilities, Thresholds, Criticality, Degrees of freedom, Accelerated growth connectivity.*

For a finite-time singularity dynamic to develop and unfold, a number of conditions must be met.

These conditions are:

1 ***The production of free energy and application of the second law of thermodynamics***
Free energy, manifested in the buildup of tensions and the storage of destructive energy in the System, is produced through the intrinsic incompatibility of increasing connectivity and security in anarchistic systems. The second law of thermodynamics applies to the System. The second law of thermodynamics ensures that free energy is put to work and that upgraded orders are implemented to allow for a lower energy state in the System. Free energy is put to work through systemic wars. Systemic wars are manifestations of criticality of the System, and instrumental in upgrading re-establishing functional orders.

2 ***Binary decisions with externalities and applying thresholds***
For a singularity dynamic to develop and unfold, the System must constitute a network of binary decisions with externalities and thresholds. Characteristics of this network, including its connectivity and the thresholds states apply to their decisions, determine the sizes and frequencies of non-systemic wars.

3 ***Local stabilities***
The System must enable the storage of tensions and destructive energy. Sufficient energy levels are realized through local stabilities that develop especially during high-connectivity regimes of relatively stable periods. These local stabilities constitute the inertia and rigidity of the System.

4 ***Criticality***
The System must reach a critical condition to enable the design and implementation of a system-wide order. At the critical point, the correlation length of the System becomes one, making the System highly susceptible to perturbations, and allowing for system-wide communication, coordination, and planning.

5 ***More than two degrees of freedom during subcritical periods, implying chaotic conditions***
When the System has more than two degrees of freedom (n > 2), the war dynamics of the System are chaotic in nature. Chaotic conditions during relatively stable periods allow for the buildup of underlying vulnerable issue clusters with fractal structures, and prevent the System from becoming hyper-excited (as was the case during the first exceptional period (1657-1763)). The number of degrees of freedom of the System is determined by the intensity of rivalries between states.

6 ***Accelerating growth rate of the System's connectivity***
Connectivity growth results in the production of free energy (see condition (1)), *accelerated* growth of connectivity – and accompanying free energy (tensions) – causes this growth to become unsustainable, and that the System at a certain point is confronted with a singularity in finite time. The singularity in finite time is reached when the System reaches (what I name) the critical connectivity threshold. At this point the System produces 'infinite' - unsustainable - amounts of free energy, and collapses as a consequence.

029 Accelerating frequencies of cycles of the finite-times singularity dynamic (1495-1945) went hand-in-hand with accelerating growth rates of their amplitudes.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Acceleration, Robustness, Fragility, Collapse, Phase transition.*

The finite-time singularity the anarchistic System produced during the 1495-1945 period, was accompanied by four accelerating cycles. The second law of thermodynamics – a law that also applies to the System – was instrumental in producing these four accelerating cycles.

The acceleration of the frequency of cycles went hand-in-hand with the accelerated growth of their amplitudes, as measured by the severity of successive systemic wars; severity is a measure of the amount of destructive energy necessarily deployed to establish an upgraded order; the measure for severity is the number of battle connected deaths of military personnel (38). Both frequency and amplitudes of cycles were 'powered' by accelerating amounts of free energy (tensions in the contingent domain) the anarchistic System produced as a consequence of the intrinsic incompatibility between connectivity (interdependence) and security in anarchistic Systems. Connectivity is the control parameter of the System, and connectivity continuously grew as a consequence of population growth during the unfolding of the singularity dynamic.

Accelerating growth rates are however, unsustainable, and when the anarchistic System reached the critical connectivity threshold (the singularity in finite time) of the System in 1939, the System produced infinite amounts of free energy (tensions), that caused the collapse of the anarchistic System, and resulted in a dual-phase transition (through the fourth systemic war (the Second World War, 1939-1945). The phase transition resulted in the implementation of two dedicated hierarchies in the core of the System (Europe) to reduce the level of anarchy (tensions) in the System. At the critical point, the System – 'theoretically' – produced (had to produce) upgraded orders at an infinite frequency and with infinite amplitudes.

The acceleration of the frequency of cycles and the simultaneous accelerated growth of amplitudes are closely related phenomena: because of the accelerating connectivity growth of the anarchistic System, accelerating amounts of free energy had to be put to work at an accelerating frequency to ensure consistency with the second law of thermodynamics. Although accelerating amounts of free energy were put to work at an accelerated frequency, the amplitudes of cycles also grew – had to grew – at an accelerating rate, to ensure release of sufficient free energy (tensions), consistent with the demands of the second law of thermodynamics.

The fact that successive relatively stable periods became increasingly robust also contributed to an acceleration of the frequency of cycles (systemic wars). The increasing robustness of successive orders implied that non-systemic energy releases – non-systemic wars – were increasingly suppressed (became increasingly 'impossible'). Ultimately – shortly before the System reached the critical connectivity threshold – the robustness of the System was 'absolute', and the System could only release energy (tensions) through systemic war. The fact that non-systemic release events became increasingly prohibitive added to the acceleration of cycles; not only produced the anarchistic System accelerating levels of free energy (tensions) during the unfolding of the singularity dynamic (1495-1945), these increasing amounts of energy could ultimately only be released through systemic wars; an effect that added to the accelerating growth rates of severities (amplitudes) of successive systemic wars. Increasing robustness and fragility (leading to collapse) of a certain category of systems – including anarchistic systems this study shows – go hand in hand, and are two sides of the same coin.

030 During its unfolding (1495-1945) the finite-time singularity dynamic accompanied by four accelerating cycles produced an optimized combination of disorder and order.

KEY WORDS *Singularity dynamic, Intrinsic incompatibility, Periodic adaptation, Performance, Evolvability, Balance, Order, Disorder, second law of thermodynamics.*

The finite-time singularity dynamic was accompanied by four accelerating cycles, each of which consisted of a relatively stable period followed by a systemic war. During relatively stable periods, the System produced free energy and tensions that negatively affected the functioning of the international order. The second law of thermodynamics ensured that tensions (free energy) were periodically put to work through systemic wars, to implement upgraded orders that were better able, at least temporarily, to cope with the higher levels of tensions that were still being produced because of the unresolved incompatibility between increasing connectivity and security, and the continuously increasing connectivity of the anarchistic System.

The finite-time singularity dynamic accompanied by four accelerating cycles produced an optimal combination of order (stability) and disorder (change) in the System, consistent with the demands of the second law of thermodynamics. The highly-optimized properties of the singularity dynamic ensured optimal performance as well as optimal evolvability of the System. Performance refers to the ability of the System during relatively stable periods, to ensure the balanced fulfillment of basic requirements of uneven states in an anarchistic System. Evolvability refers to the ability of the anarchistic System to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic war.

031 The four cycles that make up the finite-time singularity dynamic (1495-1945) are the units of analysis.

KEY WORDS *Singularity dynamic, Cycles, Unit of analysis.*

In efforts to make sense out of the (war) dynamics of the anarchistic System, and to identify regularities and patterns, historians used different perspectives, including analysis of war data on a century-by-century basis, categorization based on the number of casualties and participating states in wars, and categorization based on alliance configurations.

Not surprisingly, historians did not find any meaningful regularities. Regularities in war dynamics and in the development of the System can only be identified when cycles are used as the unit of analysis, and the fundamental differences between non-systemic and systemic wars are recognized and taken into account. Four such cycles can be identified during the unfolding of the finite-time singularity dynamic (1495-1945).

032 Successive upgraded orders that were implemented through four successive systemic wars during the period 1495-1939, already at an early stage revealed the direction of development of the anarchistic System towards its eventual collapse, and the implementation of dedicated hierarchies in the core of the System (Europe), through a dual-phase transition (1939-1945).

KEY WORDS *Singularity dynamic, second law of thermodynamics, Integration, Direction of development, Dedicated non-anarchistic hierarchies.*

As a consequence of the intrinsic incompatibility between (increasing) connectivity and security in the anarchistic System, the System produced accelerating amounts of free energy (tensions). Consistent with the second law of thermodynamics the free energy (tension) was put to work at an accelerating pace, through systemic wars, to implement upgraded orders that allowed for a lower energy state of the anarchistic System. In the contingent domain, these upgraded orders resulted in increasingly comprehensive organizational arrangements (between states in the System) that underpinned international orders (relatively stable periods).

However, despite these efforts, when the critical connectivity threshold was reached in 1939, the anarchistic System produced infinite amounts of free energy (tensions), it could no longer 'handle'; the infinite intrinsic incompatibility between connectivity and security could at that point no longer be bridged with an upgraded order in the anarchistic System. As a consequence, the anarchistic System collapsed, and experienced a dual-phase transition, that led to the simultaneous implementation of two non-anarchistic hierarchies in the core of the System, and a first global order at a global scale.

The implementation of dedicated non-anarchistic hierarchies in the core of the System was a logical and predictable next step. The System at that point (1939), only had two choices to ensure compliance with the second law of thermodynamics: decrease the System's connectivity or implement non-anarchistic hierarchies, that encompass a number of states, to accomplish a reduction in the amounts of free energy the anarchistic System would produce. A reduction in connectivity – implying a significant decrease in population size and growth – was no option. The System 'chose' to implement two dedicated non-anarchistic hierarchies in its core instead.

033 Population growth and the unfolding of the singularity dynamic accompanied by four accelerating cycles (1495-1945), qualify as coevolving – mutually reinforcing – dynamics.

KEY WORDS *Singularity dynamic, Population growth, Basic requirements, Reinforcing dynamics, Survival.*

Population growth resulted in connectivity growth of the System; connectivity growth led to the production of free energy and tensions, as a consequence of the intrinsic incompatibility between increasing connectivity and security in anarchistic systems. The second law of thermodynamics ensured that the tensions (free energy) that continuously accumulated in the System were periodically put to work, to implement upgraded orders that allowed for a lower energy state in the System. These conditions and dynamics – and the laws that apply – produced the highly-optimized finite-time singularity dynamic accompanied by four cycles (1495-1945). The performance (enabling the balanced fulfillment of basic requirements by uneven states in the anarchistic System) and evolvability (ensuring timely adaptation to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars) of the anarchistic

System optimized the collective survival changes of humans and populations in the System, and enabled their continued growth.

High population growth – and the connectivity growth of the anarchistic System it implied – assured that the singularity dynamic (1495-1945), was always provided with enough free energy (tensions), to enable its further development and unfolding. In other words: the finite-time singularity dynamic enabled population growth, while at the same time, population growth enabled the undisturbed development and unfolding of the finite-time singularity; both dynamics reinforced each other.

034 The urge of humanity – of populations of states – to survive, the need to fulfill basic requirements to ensure survival, and the physical laws that apply to the free energy (tensions) that is produced in the System provide constancy in terms of the interactions and dynamics in the System.

KEY WORDS *Singularity dynamic, Competition, Order, Disorder, second law of thermodynamics, Acceleration, Survival, Critical connectivity threshold, Collapse, Dual-phase transition.*

The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) can be considered a competition between two tendencies of the System: a tendency towards disorder and a tendency towards order. Issues, tensions, and destructive energy the System produced contributed to its disorder. Issues, tensions, and destructive energy are products of the intrinsic incompatibility between increasing connectivity and security in anarchistic systems. Disorder increasingly hampered the functioning (the performance) of the anarchistic System by inhibiting the ability of uneven states to ensure the balanced fulfillment of their basic requirements.

The engine of disorder is connectivity growth in the anarchistic System. The second law of thermodynamics determined the response of the System to the production of free energy. Consistent with the second law of thermodynamics, free energy (tensions) in the System were periodically put to work to implement upgraded orders that allowed for a lower energy states of the System. Because of the accelerated production of free energy in the System, upgraded orders were – and had to be – implemented at an accelerating frequency.

In the contingent domain of the System these deterministic dynamics played out in a different setting: orders were upgraded through systemic wars, and led in the contingent domain to increasing levels of – arrangements for – integration, that were embedded in successive international orders. Through increasingly comprehensive arrangements (contained in successive international orders that were implemented), states tried to prevent and restrain tensions and wars in the System. However, despite these efforts, the System still produced accelerating amounts of free energy; the orders that were implemented did not resolve the intrinsic incompatibility between connectivity and security, that constitutes the 'engine' of free energy production in anarchistic systems.

So, order and disorder continued competing, until the anarchistic System ultimately collapsed when in 1939 it reached the critical connectivity threshold; at that point the competition between order and disorder was 'absolute' and the System produced infinite amounts of free energy as a consequence; this condition could lead to self-destruction of states and their populations.

In response to this condition, the System produced a dual-phase transition (through the fourth systemic war, the Second World War, 1939-1945), consistent with the second law of thermodynamics, and in the contingent domain enabled by the urge to survive of humans, populations and states they were organized in.

The phase transition resulted in the implementation of two dedicated (non-anarchistic) hierarchies in Europe (the core of the System). In the respective dedicated hierarchies, the competition between order and disorder was resolved. However, at the same time as the dedicated hierarchies were implemented in Europe, the phase transition led to the implementation of the first global international order of the now global anarchistic System. This upscaling of the anarchistic System from a European (regional level) to global level, implied that the competition between order and disorder would now be continued and unfold at a global scale.

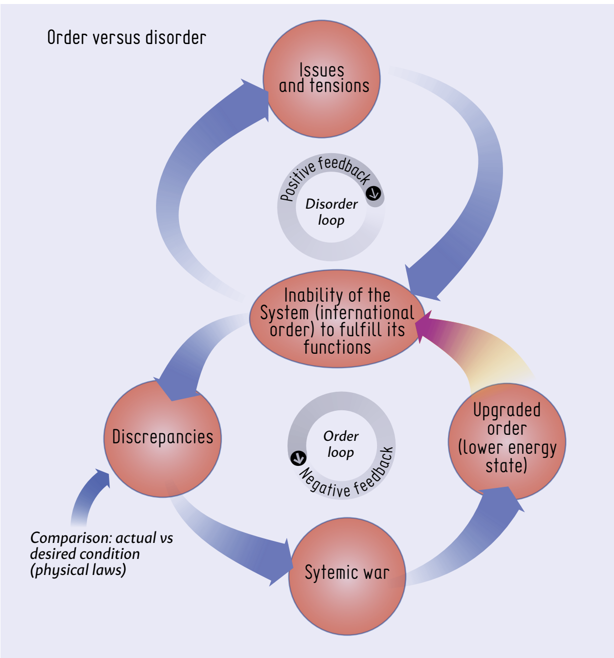


Figure 75
This figure depicts the competition between order and disorder that resulted in a finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945).

035 The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) to a certain extent qualifies as a punctuated equilibrium dynamic.

KEY WORDS *Singularity dynamic, Punctuated equilibrium dynamic, Evolution.*

"Punctuated equilibrium theory makes two contentions: that evolutionary change (or at least very significant proportions thereof) occurs in rapid bursts over short intervals of time, and that there is relative stasis after the punctuational burst" (62).

It can be argued that the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), qualifies as a punctuated equilibrium dynamic. However, this perspective is not in all respects exact: significant evolutionary change also takes place during relatively stable periods. Great Power status dynamics for example typically take place during relatively stable periods, and are then during punctuations (systemic wars) embedded in the upgraded order of the System.

Relatively stable periods and periods of criticality (systemic wars) are inseparably linked: during high-connectivity regimes of relatively stable periods the System is charged for a next systemic war.

036 The ever-expanding populations of states ensured a continuous input of free energy in the anarchistic System.

KEY WORDS *Population growth, Connectivity growth, Intrinsic incompatibility, Free energy.*

Population growth, an increase in average age, and increasing standards of living result in increasing demands for basic requirements in the System. States are responsible for the balanced fulfillment of the basic requirements of their populations, including their security. Population growth results in increasing connectivity of the System (56), and in increasing interdependence between states, including security-interdependence. Increasing connectivity in an anarchistic System leads to the production increasing levels of free energy (tensions) in the System. Free energy is produced through the intrinsic incompatibility between increasing connectivity and security in anarchistic systems. Connectivity is the driving force – the control parameter – of the finite-time singularity accompanied by four accelerating cycles that developed and unfolded in the System during the 1495-1945 period.

037 The singularity dynamic is a self-reinforcing dynamic: Population growth of states in the anarchistic System produced the free energy that powered the development and unfolding of the finite-time singularity dynamic during the 1495-1945 period, and 'at the same time' the singularity dynamic enabled population growth of states by ensuring that their basic requirements were fulfilled.

KEY WORDS *Population Growth, Singularity dynamic, Self-reinforcement.*

As discussed, connectivity is the driver of the finite-time singularity dynamic that unfolded in the anarchistic System during the 1495-1945 period. Connectivity is a function of population size; and population growth results in increasing connectivity of the System.

Through the singularity dynamic accompanied by four accelerating cycles, the System ensured the balanced fulfillment of the basic requirements of uneven states in the anarchistic System. Each time the anarchistic System reached dysfunctional energy (tension) levels, that hindered the fulfillment of basic requirements of states, the order of the System was upgraded through systemic war, to adjust to its increased connectivity and to ensure better tension control. Through these upgraded orders populations of states in the System during relatively stable periods could further grow. The finite-time singularity dynamic qualifies as a self-reinforcing dynamic, which ensured that its increasing energy-demands – to ensure its further development and unfolding – were always met.

038 Finite-size effects caused stagnation and impacted the development and unfolding of the finite-time singularity dynamic (1495-1945).

KEY WORDS *Singularity dynamic, Cycles, Acceleration, Critical connectivity Threshold, Finite-size effects, Theoretical and actual life spans, Theoretical severity, Actual severity.*

During the unfolding of the singularity dynamic (1495-1945), when the singularity in finite time (the critical connectivity threshold, 1939) was nearly reached, it became impossible to meet the theoretical 'infinite' demands of the finite-time singularity dynamic. At the critical connectivity threshold (the singularity in finite time) the singularity dynamic produced infinite amounts of free energy, and the frequency of cycles and their amplitudes (the destructive energy that had to be deployed) also became infinite. The production and deployment of infinite amounts of destructive energy at an infinite frequency obviously is impossible, also considering that such a requirement implies self-destruction. Finite-size effects had their impact in the final stages of the finite-time singularity dynamic: While the singularity dynamic pushed the System to theoretical infinity, limited-size effects increasingly hampered and distorted the actual dynamics.

To determine to what extent finite-size effects distorted the actual finite-time singularity dynamic accompanied by four accelerating cycles, I examined the development of the life spans and severities of the components of the actual and theoretical singularity dynamics (as described in part II).

1 ***Examination of theoretical and actual life spans of cycles***
Extrapolation of the life spans of cycles, international orders, and systemic wars of the actual and theoretical singularity dynamics show that, for example, the theoretical and predicted actual life span of the fifth systemic war is negative. This suggests that the actual, as well as theoretical, singularity dynamic reached its singularity in finite time during the fourth systemic war. This finding also suggests that the theoretical singularity dynamic is not in all respects consistent.

Extrapolation of actual and theoretical life spans (LS's)						
Cycle	Actual cycle	Actual IO	Actual SW	Theo. cycle	Theo. IO	Theo. SW
1	153	123	30	168	138	30
2	167	144	23	154	130	23
3	103	99	4	103	99	4
4	27	21	6	22.5	20	2.5
Predicted 5	0.5	9	−7	−10.5	≈ 0	−10.5

Table 59 *This table shows the life spans of cycles, international orders (IO), and systemic wars (SW) of the actual and theoretical singularity dynamics, and the extrapolated life spans for both singularity dynamics of an imaginary fifth cycle. The figures/data concerning the first four cycles are based on Levy's dataset (38).*

2 ***Examination of theoretical and actual severities of cycles***
Extrapolation of the severities of cycles, international orders, and systemic wars of the actual and theoretical finite-time singularity dynamics show that the actual severity of non-systemic wars during the fifth relatively stable period would have been negative (severity is defined as the number of battle-connected deaths (BCD) of military personnel, (38)).

I assume that this 'hypothetical' effect (a negative total severity of non-systemic wars during a hypothetical fifth international order) points to the dysfunctionality of the anarchistic System, and its unavoidable collapse in 1939.

Extrapolation of actual and theoretical severities Severities in terms of battle connected deaths of military personnel (Expansion wars excluded, data from Levy (38))						
Cycle	Actual cycle	Actual IO	Actual SW	Theo. Cycle	Theo IO	Theo SW
1	2,976,000	1,005,000	1,971,000	3,036,000	1,065,000	1,971,000
2	7,550,300	5,018,300	2,532,000	5,750,000	850,000	4,900,000
3	8,425,080	690,780	7,734,300	8,720,000	620,000	8,100,000
4	13,00,3300	55,000	12,948,300	11,500,000	400,000	11,100,000
Predicted 5	15,727,840	-102,110	15,829,950	14,342,000	177,500	14,164,500

Table 60 *This table shows severities of wars during cycles (in terms of BCD), international orders (IO), and systemic wars (SW) of the actual and theoretical singularity dynamics, and the extrapolated severities for both singularity dynamics of an imaginary fifth cycle. The figures/data concerning the first four cycles are based on Levy's dataset (38).*

I also assume that states in the System during the fourth international order (1918-1939), were confronted with 'finite-size effects' that made states reluctant to start and/or join (non-systemic) wars and promoted a 'wait-and-see' approach to developments in the System; states wanted to prevent and delay the next war as long as possible, sensing (because of the increasing tensions in Europe), that the next war would be large and severe, and that much would be at stake. These finite-size effects included:

1) Recovery from physical and social destruction caused by the preceding third systemic war (the First World War, 1914-1918);
2) War weariness caused by the preceding third systemic war (the First World War, 1914-1918;
3) Dysfunctionality and unavoidable ineffectiveness of the fourth international order because of high tension levels produced by the increasing incompatibility between increasing connectivity and security in the anarchistic System;
4) The need for states to ensure balanced fulfillment of their basic requirements or risk internal instability and collapse. Balanced fulfillment had become problematic because of (1), (2) and (3);
5) Time needed for the preparation for the next war, requiring mass production, mobilization, and deployment of destructive energy. This decision was delayed as long as possible because of (1) and (4), and in efforts to avoid provocations that would trigger a next war.

039 Severity of successive cycles is a power-law function of population size, and super linear scaling suggests that systemic wars are social in nature.

KEY WORDS *Severity, Systemic wars, Population size, Power-law, Super linear scaling, Cities.*

Scaling relations between population size of the System and certain properties of the System's dynamics support the assumption that population size and a number of its properties are related (for this particular aspect see also: (6), (7), (9), (12))

As Bettencourt *et al.* explain (11), “Scaling as a tool for revealing underlying dynamics and structure has been instrumental in understanding problems across the entire spectrum of science and technology.” It seems that this also is the case for the System and its war dynamics.

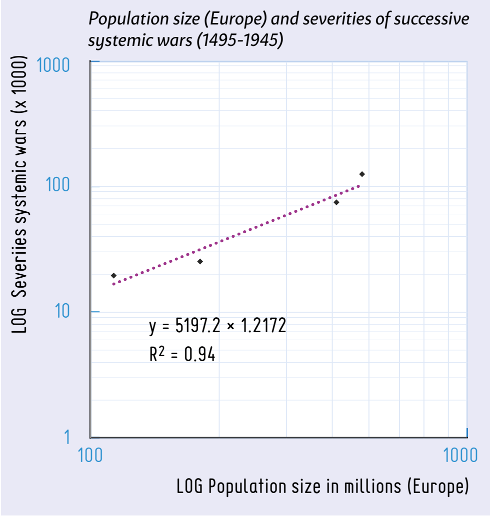
The scaling relationships that can be identified for the System show similarities with certain scaling relationships for cities (11). The similarities between exponents of power laws that describe these relations, suggest that maybe similar ‘mechanisms’ apply to urban systems and to the international orders of the anarchistic System (1495-1945) studied in this research.

The figure below shows the scaling relationship between population size and the severity of successive systemic wars on a double logarithmic scale. This figure suggests that the severity of successive systemic wars is a power-law function of population size; the exponent ≈ 1.22 implies super linear scaling.

Population size and severities of systemic wars (1495-1945)			
	Start SW	Pop. size Europe (in millions)	Severity (in BCD)
SW 1	1618	115	1,971,000
SW 2	1792	195	2,532,000
SW 3	1914	450	7,734,300
SW 4	1939	525	12,948,300

Table 61 *This table shows the population size of Europe (in millions), at the start of the respective systemic wars (SW), and the severities of these wars in BCD.*

Figure 76
This figure shows in a plot, the population size of Europe versus the severity (in terms of BCD) of successive systemic wars, on logarithmic scales.



Concerning urban systems, Bettencourt et al. observe, in case β is in the range 1.1 - 1.3 > 1, This "signifies increasing returns with population size and is manifested by quantities related to social currencies, such as information, innovation and wealth, associated with the intrinsic social nature of cities". I assume that systemic wars are instrumental in periodically upgrading the order of the anarchistic System, to ensure an optimal balance between order and disorder in the System and to ensure its performance and evolvability.

This balance enables states to fulfill their basic requirements, and survive, and serves a social purpose: The Beta ($\beta \approx 1.217$) of severities of systemic wars falls in the same range as the Beta's for social properties of urban systems. The question is if this is a coincidence, or that a universal social dynamic is at play that underlies this phenomenon and certain phenomena in city systems; inextricably linking these phenomena in an integrated dynamical network.

040 The increasing connectivity of the System, a function of its population size, underlies the super linear scaling of severities of systemic wars the anarchistic System produced during the 1495-1945 period.

KEY WORDS *Connectivity, Population size, Super linear scaling, Severity systemic wars.*

Super linear scaling can be observed in the severity of successive systemic wars as a function of population size of the System. This statement is consistent with a similar hypothesis regarding cities and their properties: "the structure of social networks underlies the generic properties of cities, manifested in the super linear scaling of almost all socio economic quantities with population size... An increase in the spreading speed (*IP: regarding city dynamics*) is considered to be a key ingredient for the explanation of the super linear scaling of certain socioeconomic quantities with city size as, for instance, rapid information diffusion and the efficient exchange of ideas over person-to-person networks can be linked to innovation and productivity" (11).

I assume that the connectivity of the anarchistic System, a function of its population size, determines the spreading speed of tensions in the System, and by doing so contributes to the acceleration of successive cycles the finite-time singularity produced (1495-1945).

041 The finite-time singularity dynamic is self-organized.

KEY WORDS *Singularity dynamic, Self-organization, Basic requirements, Deterministic laws, Rules.*

The finite-time singularity dynamic accompanied by four accelerating cycles that developed and unfolded during the 1495-1945 period is a self-organized dynamic; it is the emergent macro outcome of a multitude of interactions between states in the anarchistic System, that continuously interacted to ensure the fulfillment of their basic requirements, for which they during the unfolding of the singularity dynamic became increasingly dependent on each other. The self-organized dynamic was produced by a number of laws and rules that apply to free energy and tensions that were produced in the anarchistic System. In the table below I specify these laws and rules:

	Deterministic laws and rules
1	Incompatibility between increasing connectivity and security in anarchistic systems results in the production of free energy (tensions).
2	Connectivity growth is the driver of the System.
3	The second law of thermodynamics applies to the free energy that is produced in the System. A number of 'principles' are closely related to this law, they include the principle that 'free energy will be put to work' and that the 'an order will be implemented that enables a lower energy state of the System'.
4	The System organizes into a network of binary decision nodes with externalities and thresholds.
5	The level of connectivity of the network of issues and states determines if the System is in a low- or high-connectivity regime; the type of regime determines the sizes and frequency of non-systemic wars.
6	Depending on the number of degrees of freedom in the System, its non-systemic war dynamics are chaotic ($n > 2$) or non-chaotic ($n = 2$) in nature.

Table 62 *This table specifies deterministic laws and rules that are necessary for a self-organized singularity dynamic to develop and unfold.*

042 The urge of humans and social systems to survive was at the core of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945).

KEY WORDS *Urge to survive, Singularity dynamic, second law of thermodynamics, Basic requirements, Survival.*

Humans and social systems must fulfill a number of basic requirements in order to survive. These basic requirements can be better fulfilled when humans and social systems cooperate. Cooperation enables the development and exploitation of economies of scale and scope. Population growth in Europe caused accelerating demands for the fulfillment of basic requirements. Apart from the quantitative effect of population growth, two other effects contributed to the continuously increasing demand for basic requirements: increase of the average life span of humans and ever-increasing levels of welfare.

The focus of states during relatively stable periods was (and is) on the fulfillment of basic requirements. However, to meet the demands of the second law of thermodynamics, the free energy (tensions) that accumulated in the System had to be put periodically to work, to implement upgraded orders that allowed for lower energy states (lower tensions) in the System. These upgrades (lower tension levels) were necessary to ensure further – continued – fulfillment of the basic requirements of states and their populations. Systemic wars can be considered 'ordering forces'.

The focus of states during systemic wars was on fighting, physical survival, and restoring security and order.

During relatively stable periods as well as systemic wars, the 'same' urge to survive is at the basis of the interactions of and between populations and states.

043 The finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period, also constituted a selection process.

KEY WORDS *Singularity dynamic, Selection, Coevolution, Optimal units, States, International orders.*

The selection process the finite-time singularity also constituted, consisted of three components: (1) selection of the optimal organization of units in the System, (2) selection of collective arrangements between states to ensure their (mutual) security (international orders), and (3) the coevolution of units and international orders. The organization and capabilities of units of the System, and the arrangements they collectively implemented – international orders – coevolved during the unfolding of the singularity dynamic.

1 *Selection of optimal units*

Units in the anarchistic System had to compete for scarce resources. Their ability to do this determined if, and to what extent, they could fulfill their basic requirements, including their security; it determined their 'fitness' to survive in the anarchistic System. Given the anarchistic nature of the System and the need to compete, units' war fighting capabilities were vital to determining their ability to fulfill basic requirements and ensure survival. War fighting capabilities comprise the abilities of units to organize, produce, and mobilize for the deployment of destructive energy.

The state, with its particular properties including control over specific geographic areas and its populations, centralization of authority and use of violence, and the ability to raise taxes (resources), emerged as the most effective form of organization. Diverse units standardized into identical state organizations.

2 *Selection of international orders*

Through systemic wars the anarchistic System designed and implemented upgraded orders that allowed for lower energy states, consistent with the demands of the second law of thermodynamics.

Systemic wars can also be considered bargaining processes. Typically, more powerful and influential states were in a better position to ensure that upgraded orders were implemented, that especially supported their interests.

3 ***Coevolution of units and international orders***
The development and selection of units and successive international orders constituted a coevolving and highly path-dependent dynamic. Units determined international orders, and international orders determined units. By implementing orders that specifically served their interests, more powerful states produced a 'powerful-become-more-powerful' effect: Powerful states implemented international orders that made them (even) more powerful, their more powerful positions could then be (further) exploited during the next systemic war.

An example of a co-evolutionary 'dynamic' between dominant states and international orders concerns a number of principles that dominant states laid down in the Peace of Westphalia (1648) following the Thirty Years' War. The arrangements that accompanied the new order, determined what standards units (states) had to meet to qualify as legitimate members of the upgraded international order, and what rules applied to their (inter)actions. By 'disqualifying' other units and certain behaviors more powerful states could consolidate their positions, and better ensure the status quo.

044 During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the System transformed from a large number of loosely connected and divers units (1495), to a highly integrated and connected System of highly-standardized states that were specialized in the production, mobilization, and deployment of high levels of destructive energy (1939).

KEY WORDS *Singularity dynamic, Divers units, Connectivity, Standardized states, System, Destructive energy deployment.*

Through selection and self-organization, the units (states) of the System, successive international orders that were implemented by units (states), and the finite-time singularity dynamic accompanied by four accelerating cycles (that was instrumental in this process and itself a product of the interactions between units (states)), coevolved during the 1495-1945 period.

As a consequence of the intrinsic incompatibility between connectivity and security in anarchistic systems, increasing connectivity of the System not only resulted in increasing (security) interdependence of states, but also in the production of accelerating amounts of free energy (tensions).

The free energy and tensions that were produced, were put to work during systemic wars (through the deployment of destructive energy). Systemic wars were instrumental in the implementation of upgraded orders, that allowed for a lower energy state of the System (consistent with the second law of thermodynamics); however, upgraded orders had to be implemented at an accelerating rate.

To ensure the fulfillment of their basic requirements, and their survival in such a 'setting', states continuously had to improve their ability to produce and deploy destructive energy. However, by doing so, they not only ensured their survival (at least temporarily), but also contributed to the further acceleration of the finite-time singularity dynamic.

To improve their ability to produce and deploy destructive energy units (states): (1) conquered and merged with other units (states) that enabled them to exploit economies of scale and scope, (2) centralized certain functions and capabilities of their integrative structures, and (3) mobilized other domains and resources in society that could be deployed during systemic wars (leading to further totalization of war).

These efforts also contributed to the unfolding of the accelerating finite-time singularity dynamic, as I already mentioned, but were ultimately self-defeating. When the anarchistic System in 1939 reached the critical connectivity threshold, it produced infinite amounts of free energy and collapsed as a consequence. 'Selfish' efforts of states to ensure their survival, now threatened them with collective self-destruction. In response to this condition – and consistent with the second law of thermodynamics – the System produced a dual-phase transition. The dual-phase transition led to the simultaneous implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and the first global international order at a global scale of the System.

045 The cycles that accompanied the finite-time singularity dynamic that unfolded in the System during the 1495-1945 period, were a consequence of delayed responses of the System to counter increasing disorder.

KEY WORDS *Singularity dynamic, High-connectivity regime, Energy storage, Free energy release deficit, Delayed response, Cycles, Acceleration.*

During the 1495-1945 period, the anarchistic System produced a finite-time singularity dynamic accompanied by four accelerating cycles; each cycle consisting of a relatively stable period followed by a systemic war. During the life span of cycles, two regimes, a low- and a high connectivity regime, can typically be distinguished.

During high-connectivity regimes of relatively stable periods, the System continued producing free energy (tensions) at an accelerating rate, while at the same time, the System's ability to release free energy (tensions) became increasingly restricted, because of the increasing stability of states in the network of issues.

Instead of being released during high-connectivity regimes, free energy (unresolved issues) were 'stored' - stocked - in the System (resulting in free energy release deficits) and crystallized in vulnerable issue clusters with fractals structures. When eventually the vulnerable issue clusters percolated the System, the System would become critical and produce a systemic war. During systemic wars the 'stocked' issues and tensions (the free energy release deficit) were put to work (released) to implement upgraded orders, that allowed for lower energy states in the System.

According to a system dynamics perspective, stocks decouple rates of flow and create disequilibrium dynamics (69). Free energy release deficits that built up in the System constituted free energy stocks (stored unresolved issues and tensions) and caused a decoupling of flows and disequilibrium dynamics. Free energy release deficits absorbed the differences between inflows and outflows and permitted inflows and outflows of free energy to differ. In equilibrium, the total inflow to a stock equals its total outflow so that the level of the stock is unchanging (69). In disequilibrium that is not the case.

During high-connectivity regimes of relatively stable periods – during the buildup of free energy releases deficits – relatively stable periods (international orders that was in place) were dominated by positive feedback. However, the moment the System became critical and produced systemic wars, the loop dominance of the System changed and goal-seeking negative feedback started dominating the System's behavior. "Whereas positive feedbacks generate growth, amplify deviations, and reinforce change, negative loops seek balance, equilibrium, and stasis... Negative feedback loops act to bring the state of the system in line with a goal or a desired state" (69). Systemic wars brought the System in line again with its desired state; upgraded orders allowed for a lower free energy state of the System and improved its functionality (its ability to fulfill basic requirements of states in the anarchistic System), at least temporarily.

Upgraded orders were desired states that ensured that the System complied with the demands of the second law of thermodynamics, and were thus the goals of the negative feedback implemented by systemic wars. Shifts in loop dominance from positive to negative goal-seeking feedback occurred in the System in 1618, 1792, 1914, and 1939.

However, the development and unfolding of the finite-time singularity dynamic, accompanied by four accelerating cycles – corrections of the disorder in the System – show that despite these corrections, the anarchistic System increasingly became in disequilibrium: the corrections could eventually not keep pace with the levels of free energy and the disorder that were produced in the System. Although, 'corrections' were implemented (through systemic wars) with an accelerating rate, and with accelerating amounts of destructive energy (amplitudes), ultimately the anarchistic System collapsed when it reached the critical connectivity threshold.

During the life span of the anarchistic System (1495-1945), the level of disequilibrium of the System (despite periodic corrective actions) increased continuously; a higher level of disequilibrium meant increased dysfunction of the System.

This dynamic not only explains why successive relatively stable periods (international orders) became increasingly short-lived, but also why each international order was more dysfunctional than its predecessors. The 'ultimate' dysfunctional international order was the fourth order (1918-1939).

046 Systemic wars qualify as goal-seeking behavior with negative feedback and constitute corrective actions of the System. From a system dynamics perspective, systemic wars qualify as overshoots that contributed to the emergence of the four cycles that accompanied the finite-time singularity dynamic (1495-1945).

KEY WORDS *Singularity dynamic, Systemic war, Cycles, Goal-seeking, Balance.*

As a consequence of the increasing incompatibility of the anarchistic System between (increasing) connectivity and security during the unfolding of the singularity dynamic (1495-1945), upgraded orders had to be implemented at an accelerating pace; the anarchistic System implemented these upgraded orders through systemic wars.

The same time as the incompatibility and free energy production of the System increased at an accelerating rate, the System's ability to store free energy (unresolved issues and tensions) during high-connectivity regimes of successive relatively stable periods, also increased at an accelerating rate.

These simultaneous developments (increasingly more storage of unresolved issues and tensions) resulted in increasingly larger gaps between the actual (dysfunctional) and desired states (functional) of the System, and larger gaps between actual and desired states typically generate larger system responses.

Such a system-response can also be observed during the unfolding of the singularity dynamic (1495-1945): Increasing discrepancies between actual and desired states of successive relatively stable periods, produced systemic wars – 'responsible' for the implementation of upgraded orders to resolve 'gaps' (as demanded by the second law of thermodynamics) – at accelerating frequencies and with accelerating intensities/severities. This mechanism explains the appearance of four accelerating cycles (oscillations) and properties in the war dynamics of the anarchistic System (1495-1945).

From system dynamics perspective oscillations – cycles – in the dynamics of a system qualify as a fundamental mode of behavior (besides positive and negative feedbacks, and stocks, for example). Like goal-seeking behavior, oscillations are caused by negative feedback loops. "In an oscillatory system, the state of the system constantly overshoots its goal or equilibrium state, reverses, then undershoots, and so on. The overshooting arises from the presence of time delays in the negative loop. The time delays cause corrective actions to continue even after the state of the system reaches its goal, forcing the system to adjust too much, and triggering a new correction in the opposite direction" (69). Sterman further explains, there are many types of oscillation, "including damped oscillations, limit cycles, and chaos. Each variant is caused by a particular feedback structure and set of parameters determining the strengths of the loops and the lengths of the delays".

The System's connectivity and thresholds defined certain properties of the four oscillations (cycles) that accompanied the finite-time singularity dynamic; these properties included: the 'pace of life' of the System, the spreading speed of tensions in the System, the stability of states during successive high connectivity regimes and the 'amounts' of free energy (unresolved issues and tensions) that could be stored in the System, during these regimes.

In case of the anarchistic System, systemic wars – goal-seeking behavior of the System – produced overshoot effects that resulted in four oscillations (cycles) that accompanied the unfolding of the singularity dynamic. Systemic wars are manifestations of criticality of the System and constitute corrective actions of the System in the contingent domain. The moment the System became critical and produced systemic wars, negative feedback loops – goal-seeking behavior – dominated the System.

By means systemic wars (the deployment of destructive energy) the System 'eliminated' discrepancies between the actual (dysfunctional and disordered) state of the System (that developed during relatively stable periods as a consequence of connectivity increase), and a desired - more ordered- state, that ensured effective and efficient fulfillment of basic requirements of states in the System. These corrective actions ensured the System's compliance with the demands of the second law of thermodynamics.

From a more 'technical' perspective, the System through systemic wars, accomplished a reset of its initial conditions and its parameters. The reset of initial conditions of the System was accomplished by the destruction of dysfunctional issues and tensions. The reset of parameters of the System – and implementation of new international orders in the contingent domain it implies – provided the System with 'new' relatively stable periods that (again) allowed for the balanced – and as a consequence more effective and efficient – fulfillment of basic requirements of states in the System.

The periodic reset of the initial conditions and parameters of the System through systemic wars had the effect of overshoots that contributed to the emergence of oscillations.

047 Criticality of the System – systemic wars – mark a shift in loop dominance from self-reinforcing behavior creating increasing levels of disorder (during relatively stable periods) to goal seeking behavior creating new order (during systemic wars).

KEY WORDS *Self-reinforcement, Change, Loop dominance.*

System dynamics arise from networks of positive and negative feedback that interact with one another (69). The existence of various feedback loops in a system does not mean that all of them have the same impact on its dynamics. The dominance of (different) loops is different and can shift over time.

In the System, periodic shifts in loop dominance can be observed: each time the System became critical and produced systemic wars, a dominant self-reinforcing (positive feedback) loop – resulting in increasing disorder during relatively stable periods – was 'replaced' by a negative feedback (goal-seeking) loop, that resulted in the implementation of upgraded orders, in compliance with the second law of thermodynamics. Systemic wars constitute the goal-seeking loops in the dynamics of the System.

The security dilemma and interacting self-fulfilling prophecies between states in the System were integral components of the self-reinforcing (positive feedback) loops that typically dominated the dynamics of the System during relatively stable periods.

048 The finite-time singularity dynamic accompanied by four accelerating cycles (oscillations), does not qualify as a damped oscillator; as a consequence of the increasing incompatibility between (increasing) connectivity and security in the anarchistic System, the System could eventually (1939) not return (again) to the same anarchistic equilibrium.

KEY WORDS *Singularity dynamic, Damped oscillator, Acceleration.*

Different types of oscillations can be distinguished, including 'damped' oscillations. The equilibrium of a damped oscillator is said to be locally stable. "Perturbations will cause the system to oscillate, but it will eventually return to the same equilibrium... While many oscillatory systems are damped, the equilibriums of other systems are locally unstable, meaning that small disturbances tend to move the system farther away from the equilibrium point" (69). The System – contrary to international orders (relatively stable periods) – does not qualify as a damped oscillator; during the unfolding of the singularity dynamic (1495-1945), the oscillations of the System increased in frequency as well as strength (amplitude).

Increasing connectivity of the System led to an increase in the level of its incompatibility, and pushed the System farther away from equilibrium towards a new stability domain. To reach this new stability domain, the System had to experience a phase transition and implement a number of fundamental changes. Sterman (69) explains: "While an equilibrium may be locally unstable, any real system must be globally stable." This is also the case for the System; if stable order is not achieved, states can no longer fulfill their basic requirements and cannot survive.

049 Despite the accelerated implementation of increasing levels of order in the anarchistic System, its ultimate collapse in 1939 was unavoidable.

KEY WORDS *Acceleration, Singularity dynamic, second law of thermodynamics, Collapse, Dual-phase transition.*

During the unfolding of the finite-time singularity accompanied by four accelerating cycles (1495-1945), the anarchistic System produced free energy (tensions) at an accelerating rate. Consistent with the second law of thermodynamics, the energy was put to work through systemic wars, also at accelerating rates. This dynamic resulted in the accelerated implementation of upgraded orders.

However, the dynamic was unsustainable. When the anarchistic System in 1939 reached the critical connectivity threshold (the singularity in finite time) it produced infinite levels of free energy that could no longer be restrained by implementing upgraded orders; the anarchistic System had run out of options, and the System experienced I dual-phase transition in response, consistent with the second law of thermodynamics. Through the dual-phase transition (fourth systemic war, the Second World War, 1939-1945) simultaneously two dedicated non-anarchistic hierarchies were implemented in the core of the System (Europe), and a first global order at a global scale of the System.

050 The fourth systemic war, the Second World War (1939-1940) and preceding systemic wars, were unavoidable deterministic responses of the System given the amounts of free energy (tensions) it produced, and the application of deterministic laws. These wars were already 'programmed' at the inception (1495) of the finite-time singularity dynamic (1495-1945).

KEY WORDS *Deterministic domain, Contingent latitude, second law of thermodynamics.*

Contrary to what historians 'believe', the development of the international system, historical events, etc. are the outcome of deterministic dynamics in the System. The latitude that is left for contingent events and dynamics (within the deterministic framework), is also defined by deterministic laws.

The fourth systemic war (the Second World War 1939-1945) for example (like all wars), was a product of a self-organized finite-time singularity dynamic accompanied by four accelerating cycles that developed and unfolded during the 1495-1945 period; its appearance (as such) was a product of the second law of thermodynamics, and not of decisions of states or ideologies states had adopted. The highly deterministic finite-time singularity dynamic determined the timing, duration, and intensity/severity of the systemic wars the System produced, as well as their outcome: the implementation of upgraded orders that allowed for lower energy states of the System (consistent with the requirements of the second law of thermodynamics).

The latitude the deterministic domain left to contingent dynamics determined the impact of decision makers and ideologies. Decision makers could determine which social issues and ideologies would be used to mobilize societies and define the purposes for which states would fight wars. It was also up to the contingent domain to determine the exact size and shape of the dedicated hierarchies that had to be implemented, as long as the demands of the second law of thermodynamics were met.

The 'Great Man Theory', suggesting that history can be explained by the impact of great men, must also be reconsidered. A great man can, at best, influence certain social dynamics by exploiting social issues and developing ideologies, but cannot change the fundamental deterministic dynamic of the System.

The fact that the finite-time singularity dynamic accompanied by four accelerating cycles was deterministic in nature implies that the life spans of successive cycles, the duration of systemic wars, the destructive energy that had to be deployed, etc., were already determined at the singularity's inception in 1495.

The fourth systemic war (the Second World War, 1939-1945) as well as the preceding systemic wars, would have happened at about the same time, without the well-known 'cast' historians now hold responsible for the outbreak of these wars; these wars were unavoidable deterministic events. A fourth systemic war (all systemic wars) would have happened anyway, and the Second World War as we know it, is just the version of the event as we shaped it, within the contingent latitude that was available.

Interacting self-fulfilling prophecies between states and the security dilemma could (and would) always ensure that the contingent dynamics in the System complied with the requirements of the deterministic domain.

051 Great Power status dynamics – changes in status of states in the contingent domain of the System – are equivalent with 'centrality-dynamics' - changes in centralities of nodes - in the deterministic domain of the System.

KEY WORDS *Deterministic domain, Contingent domain, Centralities of nodes, Great Power status dynamics, Realignment.*

Each state in the System can be considered a node in an underlying network of nodes (states) with different properties. The centrality of Great Powers is a function of their connectivity in the network of issues and states in the System, and their destructive energy potential.

These dynamics are powered and shaped by the continuous connectivity growth of the System, the differentiated growth of states (nodes), the free energy that is produced as a consequence of the intrinsic incompatibility between connectivity and security in anarchistic systems, and the laws that apply to these dynamics.

Typically, Levy's data shows, Great Power status dynamics – changes in Great Power status, in centrality – take place during relatively stable periods (international orders). These changes I argue, are then 'formalized' - implemented - during systemic wars that follow, when the actual centralities of states (Great Powers) are re-aligned with the rules that apply to (inter) actions of states during the next international order (relatively stable period).

052 Finite-size effects cut short the finite-time singularity before the theoretical critical point was of the singularity was reached (19…).

KEY WORDS *Singularity dynamic, Finite-size effects, Critical point.*

In part II (Perspectives) I constructed the theoretical finite-time singularity, taking into consideration a delay in the unfolding of the finite-time singularity that was caused by abnormal periodic non-systemic war dynamics during the first exceptional period (1657-1763). The theoretical finite-time singularity suggests that the critical connectivity threshold was actually 'programmed' around 1954. The theoretical singularity dynamic shows that the fourth systemic war would theoretically produce a fifth relatively stable period, and a fifth systemic war, etc. The table below specifies the theoretical cycles that would have followed the fourth systemic war (the Second World War, 1939-1945) at an accelerating rate.

The finite-time singularity put such demands on the anarchistic System for destructive energy, and caused such levels of destruction, that at a certain point – before the theoretical singularity in finite time was reached – the dynamic could no longer be sustained. The singularity dynamic was cut short before its theoretical critical point was reached because of what are called finite-size effects: practical limitations that prohibit further development.

Continuation of the finite-time singularity dynamic required accelerating and ultimately infinite amounts of resources, that had to be transformed at an accelerating (and ultimately infinite) rate into destructive energy. These requirements undermined the ability of states, to ensure the balanced fulfillment of basic requirements other than security during increasingly shorter periods, during which states already had to prepare for the next systemic war.

The fourth systemic war also caused significant destruction of the industrial base of two Great Powers (Germany and Japan) and of their social and political 'fabric'; unconditional surrender was the aim and was accomplished. The efforts the fourth systemic war required affected the ability of states to produce and mobilize enough destructive energy for a theoretical fifth systemic war (a 'Third World War', starting around 1954). Apart from these practical limitations that could not be overcome, states and their populations also became war-weary, a sentiment that undermined the ability of states to mass-mobilize for another systemic war. These finite-size effects, practical limitations to meet theoretical demands of the accelerating finite-time singularity dynamic, in combination with war weariness, also restrained the United States, at that stage the only Great Power in possession nuclear weapons, from 'pushing back' the Soviet Union in Europe, and ensuring the Soviet Union's full compliance to the agreements made in Yalta concerning the order that would be implemented.

053 The System (1495-1945) qualifies as a network of binary decision switches with externalities and thresholds.

KEY WORDS *Network, Binary decisions, Thresholds, Externalities.*

The System can be defined as a network of binary nodes or binary decision switches of states; each state can be considered a binary-switch. As far as war decisions are concerned, decision-makers of states can only choose between two options: 'war' or 'no war'; other options are not available. War decisions are, to a very high degree, based on the decisions of other states; the term 'externalities' refers to this property of war decisions; 'thresholds' define when – in case of what fraction – states switch to positive war decisions. These fractions are defined by the quotient of the number of connected states that are in favor of war, and the total number of states connected to the issue.

054 Identification of the finite-time singularity dynamic (1495-1945) requires a long-term perspective.

KEY WORDS *Long-term perspective, Self-organization, Cycles.*

Bak explains (5) that a long-term perspective is necessary to understand the behavior of systems. In particular, large-scale, infrequent events define a system's behavior: "Self-organized critical systems evolve to the complex critical state without interference from any outside agent. The process of self-organization takes place over a very long transient period. A long process of evolution, whether in geophysics or biology, always creates complex behavior. It cannot be understood by studying the systems within a time frame that is short compared with this evolutionary process. The phrase 'you cannot understand the present without understanding history' takes on a deeper and more precise meaning. The laws for earthquakes cannot be understood just by studying earthquakes occurring in a human lifetime, but must take into account geophysical processes that occurred over hundreds of millions of years and set the stage for the phenomena that we are observing. Biological evolution cannot be understood by studying in the laboratory how a couple of generations of rats or bacteria evolve. The canonical example of SOC is a pile of sand. A sand pile exhibits punctuated equilibrium behavior, where periods of stasis are interrupted by intermittent sand slides. The sand slides, or avalanches, are caused by a domino effect in which a single grain of sand pushes one or more other grains and causes them to topple. In turn, those grains of sand may interact with other grains in a chain reaction. Large avalanches, not gradual change, make the link between quantitative and qualitative behavior, and form the basis for emergent phenomena. If this picture is correct for the real world, then we must accept instability and catastrophes as inevitable in biology, history, and economics. Because the outcome is contingent upon specific minor events in the past, we must also abandon any idea of detailed long-term determinism or predictability."

A long-term perspective is also necessary to identify and understand the behavior of the System. The finite-time singularity dynamic accompanied by four accelerating cycles the System produced during the 1495-1945 period can only be identified from a long-term perspective. It also shows that wars, systemic and non-systemic, are not isolated events that happen coincidentally, but are the outcome of a coherent dynamic, showing remarkable regularities.

By analyzing events and speculating about causalities, historians argue that the First and Second World Wars seem to be closely related. This study shows that all wars are an integral part of the same underlying dynamic and that, in fact all (systemic) wars are closely related phenomena; relationships not necessarily exists at 'event level' (in the so-called contingent domain), but certainly at an 'underlying' level, in the deterministic domain of the System.

055 Competition between order and disorder: A dynamical systems perspective.

KEY WORDS *Singularity dynamic, Oscillations, Competition, Order, Disorder, Restoring force, Delay, Positive feedback, Negative feedback, Loop-dominance.*

Adynamical systems perspective is always useful for understanding the dynamics of a system. According to a system dynamics perspective, it is the feedback structure that generates the behavior of systems (69). The finite-time singularity dynamic (1495-1945) was accompanied by four (accelerating) cycles, oscillations. These oscillations can be considered the manifestation of competition between order and disorder in the anarchistic System.

The logic from this perspective is as follows: In the case of competition between disorder (e.g., caused by forces trying to maintain the status quo) and order (e.g., requiring periodic change), a reinforcing (positive feedback) mechanism competes with a balancing (negative feedback) mechanism. Initially, the positive feedback mechanism, by producing higher amounts of issues and tensions (i.e., disorder) dominates the dynamics of the System. Because the System becomes increasingly dysfunctional, there is at a critical point, a shift in loop dominance that causes the balancing mechanism to become more dominant. At the critical point, the ordering/restoring force produces a systemic war in order to re-establish a new order that is better adjusted to the increased connectivity of the System. Although systemic wars are above all else associated with and experienced as disorder (*on* the network, in the contingent domain), they are in fact ordering forces.

The ordering (restoring) force is activated with a certain delay that is caused by the inertia of the System. Inertia is contained in the connectivity of the System (in the deterministic domain, which I refer to as the local stability that high levels of connectivity at a certain point produce) and in forces that try to maintain the status quo to safeguard their interests (in the contingent domain). Because the restoring force – the balancing mechanism – emerges with a delay, the System produces oscillations. This is a dynamic-system explanation for the oscillations that can be observed. According to this perspective, every type of oscillation has, at its core, a negative feedback loop with delays. The systemic war is activated when the System has reached a critical point, and results from the nonlinear interaction of the two basic feedback structures I just described.

At the critical point, the System produces a systemic war. Through systemic wars, the System (re-)establishes order. The emergence of a systemic war means that the balancing (negative feedback) loop has become dominant. The moment the international order is implemented, the reinforcing loop produces disorder again and becomes dominant once more.

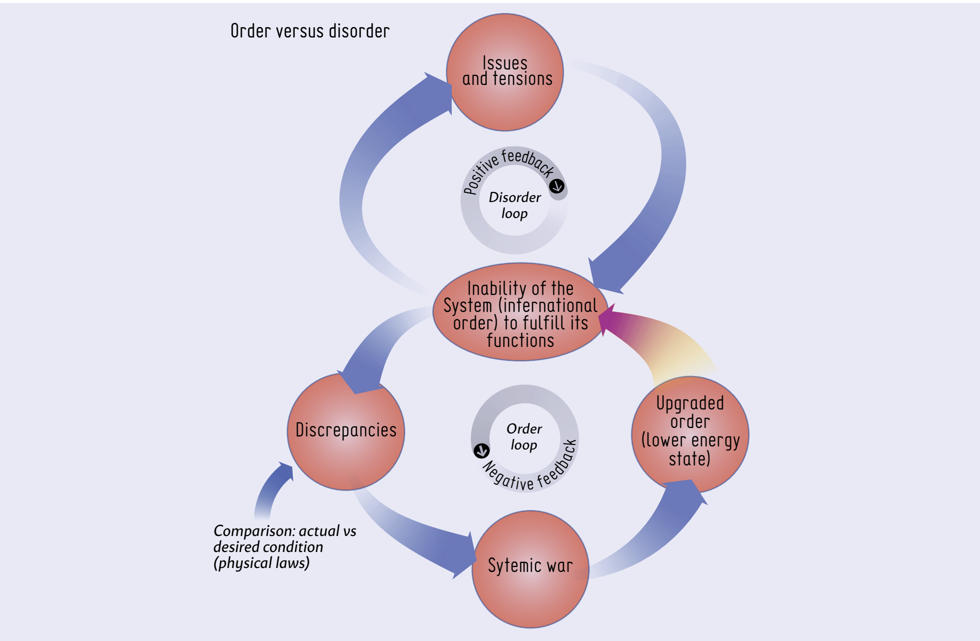


Figure 77 *This figure shows the causal loop diagram of a single oscillation – a relatively stable period – followed by a systemic war. Two interacting loops can be identified: A positive feedback loop and a balancing negative feedback loop. The self-reinforcing positive feedback loop in this model consists of two variables: the inability of the international order to fulfill its function, and issues and tensions.*
At a certain point, a vulnerable issue cluster percolates the System, and the System becomes critical; criticality results in systemic war. At that point the actual and desired state of the System as demanded by the second law of thermodynamics, can no longer be sustained. The order loop becomes dominant and ensures that an upgraded order is implemented (through a systemic war).

056 The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) can be depicted as is a competition between order and disorder in the System.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Relatively stable periods, International orders, systemic war, Upgraded orders, Order, Disorder, Competition, Stability, Robustness, Acceleration, Cycles.*

I argue that two competing forces, order and disorder, produced the finite-time singularity accompanied by four accelerating cycles that can be observed in the war dynamics of the System during the period 1495–1945.

This 'competition' arose from the increasing incompatibility between increasing connectivity of the System and security, intrinsic to anarchistic systems. Fulfillment of basic requirements in an increasingly interdependent anarchistic system requires a certain order to enable regular interactions and provide certain stability and predictability. Increasing connectivity increases interdependence and contributes (at least in some respects) to order in the System. However, as a consequence of increased connectivity (increased interdependence), the anarchistic System also produces more issues, tensions, and rivalry between states. As a consequence, more free energy (tensions) is produced. Moreover, the security dilemma works as a self-reinforcing mechanism, contributing to the accelerated buildup of issues, tensions and destructive energy. Thus, connectivity growth not only produces order, but (in an anarchistic System) also insecurity and disorder. Connectivity growth has two contradictory effects: it increases the ability of states to fulfill their basic requirements, but also creates insecurity and tensions 'at the same time'.

The typical life cycle of international orders (relatively stable periods) shows that initially the disordering force is stronger that the ordering force, and that an increasing number of issues and tensions build up in the System. At a certain point however, the System becomes critical as a consequence of the disordering force and produces a systemic war to re-establish order and to allow for a lower energy state of the System. This response is consistent with the demands of the second law of thermodynamics.

By doing so – by implementing an upgraded international order – the fulfillment of basic requirements by states is ensured again, at least temporarily.

Systemic wars are forces for order despite the fact that they create increasingly high levels of destruction and suffering in the System.

A number of factors and conditions allow for the buildup of issues and tensions – disorder – in the anarchistic System. The ability of successive relatively stable periods (international orders) to 'restrain' ever-higher levels of free energy (tensions), makes that the level of disorder during successive cycles could increase.

A number of factors and conditions determine the level of disorder relatively stable periods (international orders) can 'handle'. It is possible to distinguish between factors and conditions that concern the deterministic and contingent domain, respectively.

1 ***Deterministic domain: increasing structural stability and robustness***
Each time an upgraded order is implemented in the deterministic domain of the System (during a critical period, systemic war), the rules that regulate interactions between nodes (states) in the System, are realigned with their actual centrality (connectedness, and potential to produce and deploy free energy). This realignment contributes to the structural stability of the System. Furthermore, increasing connectivity results in the System's increasing robustness, that is the System's ability to 'resist' (absorb) perturbations without producing non-systemic energy releases (non-systemic wars). The increasing structural stability and robustness of the System, make that the System during successive relatively stable periods, can 'handle' increasingly higher levels of disorder.

2 ***Contingent domain: Incentives for dominant states to maintain the status quo***
These factors and conditions in the deterministic domain, have 'counterparts' in the contingent domain of the System. During systemic wars states collectively design and implement organizational arrangements that underpin international orders. Over time these arrangements became more comprehensive. During systemic wars dominant states ensure that these arrangements support their (specific) interests, by including certain privileges in the just mentioned organizational arrangements. These arrangements contribute to the structural stability of the System, and give dominant states incentives to maintain the (favorable) status quo. This development contributes to the System's (contingent domain's) ability to handle higher levels of disorder.

During the unfolding of the finite-time singularity dynamic (1495-1945), driven by connectivity growth, increasing friction between states, and efforts to maintain the status quo, the conflict between order and disorder intensified. As a consequence, the System reached four times a critical point, resulting irrevocably in (four) systemic wars.

Increasing connectivity of the System (during the 1495-1945 period) not only resulted in the production of increasing amounts of free energy (tensions), but also caused an increase in the pace of life of the System (as I explain later). As a consequence of the increased pace of life of the System, information - including tensions- could spread at higher speeds. The combined effects of increasing connectivity of the System resulted in an acceleration of the cycles that accompanied the finite-time singularity dynamic (1495-1945), and in a simultaneous increase of their amplitudes.

057 During the development and unfolding of the first finite-time singularity dynamic (1495-1945), the anarchistic System became increasingly unstable.

KEY WORDS *Singularity dynamic, Stability, Instability, Collapse.*

Stability concerns the property of a system to maintain itself within a certain stability domain; to maintain a certain equilibrium. The (accelerating) need to implement upgraded (international) orders (that 'underlie' relatively stable periods) to maintain 'balance', point to the System's increasing instability.

The instability of the anarchistic System lies in the accelerating production of free energy (tensions) in the System, which is a consequence of the intrinsic incompatibility of (increasing) connectivity and security in anarchistic systems; free energy (tensions) as an internal state grows without bounds.

The equilibrium of the anarchistic System is in other words unstable: the oscillations (cycles) of the anarchistic System accelerated during the unfolding of the first finite-time singularity dynamic (1495-1945): the frequency as well as the amplitudes of successive oscillations accelerated, until the System's collapse in 1939. The dynamics of the current (global) anarchistic System (1945-...) suggest that the current System also is unstable: At this point in time the System is in the first cycle of the second singularity dynamic (1945-...), that will also – I expect – produce a number of accelerating cycles.

058 The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) and the singularity dynamic that is now unfolding in the System, can be considered regulatory 'networks'.

KEY WORDS *Singularity dynamics, Acceleration, Regulatory network, Criticality, Saturation, Collapse.*

The finite time singularity dynamic accompanied by four accelerating cycles that developed and unfolded in the anarchistic System during the 1495-1945 period, and a second singularity dynamic that is now unfolding (1945-...) - can be considered 'regulatory networks' that serve the interests of nodes (states and their populations) in the anarchistic System.

Mattick et al. explain regulatory networks as follows: "networks that are simple connection networks, such as telephone exchanges or the Internet, are able to grow in an unconstrained way. In contrast, regulatory networks, such as those in biology (for example, the network of regulatory proteins that controls gene expression in bacteria), engineering, or society, are accelerating networks that must be able to operate in a globally responsive way. Such global responsiveness, we argue, imposes an upper size limit on the complexity of integrated systems due to the costs incurred by the need for an increased number of connections and levels of regulation" (41).

Simple connection networks, "can become large precisely because they have no need to rapidly integrate information from or globally respond to the current state of their nodes". "This situation is different with functionally organized systems whose operation is reliant on the integrated activity of any or all of its component nodes." "In such circumstances, the number of informative connections per node must increase with the size of the network. This means that the total number of connections between nodes scales faster than linearly with node number. Such networks are termed 'accelerating networks'." "These accelerating connection requirements, in principle and in practice, impose an upper limit on the functional complexity that integrated systems can attain". "This in turn means that the size and complexity of such systems must sooner or later reach a limit where the number of possible connections becomes saturated or where the accelerating proportional cost of these connections becomes prohibitive".

International order can be considered regulatory networks (systems) that must maintain a certain balance in the System, by regulating the network of issues (of which states are integral components).

I argue, that international orders in the System become saturated, and collapse as a consequence, the moment vulnerable issue clusters percolate the System. Criticality and systemic war are indicative for the System's collapse. At critical points the System is highly susceptible for perturbations, because its correlation length has then become one. A correlation length of one enables system-wide communication (including of perturbations), system-wide coordination and system-wide planning.

The same properties that result in the collapse of the regulatory network of the System, are used during systemic wars to collectively design and implement upgraded orders.

059 This study discloses a simple and deeper order in the (war) dynamics and development of the System; its existence we were until now not aware of.

KEY WORDS *Order, Theory, Physical laws, Contingent latitude, Shortcomings in research methods.*

The deeper order I discuss in this study can be summarized as follows: population growth of states in the anarchistic System results in the production of free energy (tensions) to which physical laws apply; these laws determine that this energy (tensions) is periodically put to work through systemic wars, to implement upgraded orders that allow for lower energy states and relative stability of the anarchistic System; relative stability enables further (population) growth. The upgraded orders that are implemented at an accelerating rate facilitate a process of social integration and expansion in the System. The physical laws determine and shape the dynamics and development of the System, and define the latitude for contingency in the System.

A number of factors contributed to our inability to reveal this deeper order. These factors include: A (too) short time span we used to analyze and make sense of the dynamics and development of the System, the normally chaotic and for that reason unpredictable nature of most wars, disruptions in war dynamics, and shortcomings in research methods.

The revelation of the deep order makes it possible to identify fundamental shortcomings in (historical) research methods and adjust them accordingly.

060 The finite-time singularity unfolded at an accelerating pace and successive systemic wars became increasingly total to satisfy the demands of the second law of thermodynamics.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Acceleration, Totality of war.*

During the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the System not only became increasingly stable, robust, and fragile, but states in the System also increasingly locked in on mobilization, production, and deployment of increasing amounts of destructive energy to meet the demands of the second law of thermodynamics. Systemic wars were, by necessity, produced at accelerating rates and with accelerating severities to ensure the unfolding of the singularity dynamic. The implication of this lock-in was that, over time, the singularity dynamic became more dominant and eventually involved all domains of states and societies, including the economic domain and the identities of states and their populations.

I assume that the second finite-time singularity dynamic will follow a similar logic.

061 The first finite-time singularity dynamic enabled population growth, while population growth 'at the same time' powered the development and unfolding of the finite-time singularity dynamic.

KEY WORDS *Singularity dynamic, Population growth, Mutual reinforcement. Self-reinforcing mechanism.*

The first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) was a self-reinforcing dynamic that was powered by increasing amounts of free energy (tensions) produced by continuously growing populations of states that had to fulfill their basic requirements in an anarchistic System. On the one hand, population growth enabled the development of the finite-time singularity dynamic; on the other hand, the optimized performance and evolvability of the singularity dynamic ensured that states and their populations could fulfill their basic requirements in an anarchistic System.

I assume that the second finite-time singularity fulfills a similar function for the current (global) System: providing balance, and enabling population growth (it requires to power its unfolding)

062 **To make sense out of the dynamics and development of the System, the cycles of the accelerating finite-time singularity dynamic must be the units of analysis.**

KEY WORDS *Singularity dynamic, Cycles, Unit of analysis, Robustness, Fragility, Structural stability.*

To make sense of the dynamics of the System, it is necessary to use the cycles of the accelerating finite-time singularity dynamic that unfolded during the 1495-1945 period as the units of analysis; furthermore, it is necessary to make a distinction between systemic and non-systemic wars. If these accelerating cycles are ignored, and if systemic and non-systemic wars are not conceived as two fundamentally different categories, then during the 1495-1945 period the total war frequency and the absolute number of wars appear to decrease over time, suggesting an increase in the stability of the System. This, however, is an incomplete and misleading observation. Although the System became more robust in regard to perturbations and non-systemic wars, and international orders became more stable, the System became more fragile in regard to systemic wars. The paradox is that while the System (1495-1945) became more structurally stable and robust, it simultaneously became more fragile.

I assume this logic also applies to the second finite-time singularity dynamic (1945-...)

063 **The first finite-time singularity dynamic accompanied by four accelerating cycles can be considered a self-reinforcing positive feedback dynamic that started when the System reached the percolation threshold in 1495. In 1939, the finite-time singularity reached the critical connectivity threshold, causing the System's collapse and a dual-phase transition by which the System ensured compliance with the second law of thermodynamics.**

KEY WORDS *Singularity dynamic, Critical connectivity Threshold, second law of thermodynamics, Collapse, Dual-phase transition.*

The anarchistic context in which states and their growing populations had to compete for resources and survive, caused tensions (free energy) in the System. In compliance with the second law of thermodynamics, this energy was put to work at an increasing rate to implement upgraded orders that allowed for a lower energy state of the System. Through this dynamic, the System produced four accelerating cycles in the 1495-1945 period. Each cycle consisted of a relatively stable international order and a relatively short critical period of systemic war.

When the finite-time singularity dynamic reached its critical connectivity threshold in 1939, the intrinsic incompatibility between interdependent connectivity and security became infinite, and the anarchistic System produced infinite amounts of tension that led to its unavoidable collapse. At that point in time, the structural stability, robustness, and fragility of the System had become absolute/infinite, and the System could no longer produce a viable upgraded order to restrain and control the infinite amount of free energy. The second law of thermodynamics forced a dual-phase transition on the System: the implementation of dedicated hierarchies in the core of the System (Europe) within which anarchy was neutralized, leading to a temporary reduction in the amount of free energy, and the simultaneous implementation of the first global order that included the hierarchies in Europe.

2 SYSTEMIC AND NON-SYSTEMIC WARS

064 Two types of wars can be distinguished: systemic wars and non-systemic; both types of war are deterministic in nature.

KEY WORDS *Systemic wars, Non-systemic wars, Free energy, Similarities, Differences, Criticality, Chaotic, Degrees of freedom, Intrinsically unpredictable, Exceptional period.*

It is possible to distinguish between two types of war: systemic and non-systemic. Both types of war are deterministic free energy (tension) releases and are the outcome of self-organized dynamics of the System.

Despite some similarities, the types of war have fundamentally different properties and functions. See below table for an overview.

Similarities and differences between systemic and non-systemic wars	
Systemic wars	Non-systemic wars
Deterministic in nature	Deterministic in nature
Define accelerating cycles that accompany a finite-time singularity (1495-1945)	Non-systemic war dynamics are normally chaotic in nature, when the number of degrees of freedom $n > 2$; or periodic or subdued, when $n = 2$, as was the case during the first (1657-1763) and second (1953-1989) exceptional periods, respectively.
Constitute free energy release events	Constitute free energy release events
Are manifestations of criticality. Criticality implies that a system's correlation length spans the System (is one); a correlation length of one enables system-wide communication, coordination, and planning.	Do not represent criticality, and do not have correlation lengths that span the System.
Produce system-wide orders.	Do not produce system-wide orders, and only have local impacts.
Are system-sized.	Are by default not system-sized. Are only system-wide when the System's dynamics are not controlled or constrained by a third degree of freedom as seen during the first exceptional period (1657-1763).
Timing, intensity/severity, and duration are highly predictable.	Are intrinsically unpredictable when $n > 2$, despite their deterministic nature, because of their high sensitivity for initial conditions. Predictability is increased when n becomes 2, and chaotic non-systemic war dynamics become periodic or subdued in nature.
The frequency and amplitudes of successive systemic wars accelerate at an increasing rate, producing a singularity in finite time.	Their absolute number and frequency decrease linearly during successive relatively stable periods of successive cycles, a trend that can be explained by the increasing robustness – local stabilities of states – in the System.

Table 63 *This table summarizes the similarities and differences between systemic and non-systemic wars.*

Systemic and non-systemic wars are contingent representations of respectively systemic and non-systemic energy releases in the System. Systemic wars are synonymous with criticality. Both categories of wars were produced by the finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period. Each cycle consisted of a relatively stable period (an international order) followed by a relatively short period of criticality in the form of a systemic war.

The free energy (tensions) the System periodically released was produced as a consequence of the intrinsic incompatibility between increasing connectivity and security in anarchistic systems; the singularity dynamic, a product of the second law of thermodynamics, organized the energy releases of the System. As a consequence of the increasing connectivity of the System, increasing levels of free energy were produced, and the pace of life in the System and the structural stability and robustness of successive relatively stable periods also increased. Through a combination of factors, systemic wars were produced at an accelerating frequency, with amplitudes (severities) that also grew at an accelerating rate. In 1939, the System reached the critical connectivity threshold – the singularity in finite time – and experienced a phase transition through the fourth systemic war (the Second World War, 1939-1945).

Typically, at criticality a system has a correlation length of one, and is highly susceptible to perturbations; a correlation length of one enables system-wide communication, coordination, and planning. Because of these properties of criticality, during systemic wars the System typically designed and implemented system-wide upgraded orders that allowed for a lower energy state (lower tensions) of the System, consistent with the requirements of the second law of thermodynamics.

Non-systemic wars were produced during relatively stable periods and only produce local effects; they were local energy releases that did not affect the order of the System itself. Non-systemic wars are normally chaotic in nature. The number of degrees of freedom (n) of the System determines the nature of non-systemic war dynamics. Abnormal non-systemic war dynamics during the first exceptional period (1657-1763) show that if the number of degrees of freedom is decreased to two (from $n > 2$ to $n = 2$), the System produces periodic non-systemic war dynamics. Periodic dynamics differ in a number of respects from chaotic non-systemic war dynamics. Periodic dynamics are more regular and predictable, and more extreme in size and severity.

When $n > 2$ (implying chaotic war dynamics) the size and severity of non-systemic wars are more restrained and an over-excited energy state in the System can be avoided. During the first exceptional period ($n = 2$), the war dynamics of the System became temporarily hyper-excited; this resulted in a number of system-wide non-systemic wars (numbers 58-77, Levy). Although, abnormal – periodic – non-systemic war dynamics during the first exceptional period (1657-1763) produced a series of system-wide war dynamics, their size did not make them systemic, and these wars did not result in the implementation of an upgraded order.

Although both types of war – systemic and non-systemic – are deterministic in nature, only certain properties of systemic wars (including their timing, duration, amount of energy that will be put to work) are (highly) predictable; on the other hand, chaotic non-systemic wars are highly unpredictable, because of their high sensitivity for initial conditions (conditions of the System at the inception of these wars).

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the System produced four systemic wars that developed very regularly. Their frequency and amplitudes grew at an increasing rate. Although chaotic non-systemic wars are unpredictable, at cycle-level this category of wars (chaotic and non-chaotic) also show remarkable regularities; analysis for example shows, that the absolute number of non-systemic wars during successive cycles (relatively stable periods) decreased linearly, implying that the robustness of successive cycles increased linearly.

Systemic wars during the first finite-time singularity dynamic (1495-1945)		
Systemic war	Name	Time span
1	The Thirty Years' War	1618 - 1648
2	The French Revolutionary and Napoleonic Wars	1792 - 1815
3	The First World War	1914 - 1918
4	The Second World War	1939 - 1945

Table 64 *This table specifies the four systemic wars during the life span of the anarchistic System (1495-1945).*

065 Systemic wars are not just scaled-up versions of non-systemic wars.

KEY WORDS *Finite-time singularity dynamic, System wars, Non-systemic wars, Size, Upgraded orders, Cycles, Oscillations, Log-periodic.*

It is not 'size' that determines the category (systemic or non-systemic) a war belongs to: as a number of system-sized wars during the exceptional period (1657-1763) shows, non-systemic system-sized wars do exist. Systemic wars effectuate reorganizations of the System: Organizational innovations (new international orders) are implemented through systemic wars. To that end, systemic wars destroy issues and tensions that increasingly hamper the System and provide a competitive platform for states to design and implement a collectively acceptable new (upgraded) order. Systemic wars produce upgraded orders that temporarily provide relative stability, enabling the relatively peaceful fulfillment of basic requirements by competing states in an anarchistic system. However, population and connectivity growth continues, and the rivalry between states will intensify again. These dynamics push the anarchistic System to the next critical point, producing the next systemic war.

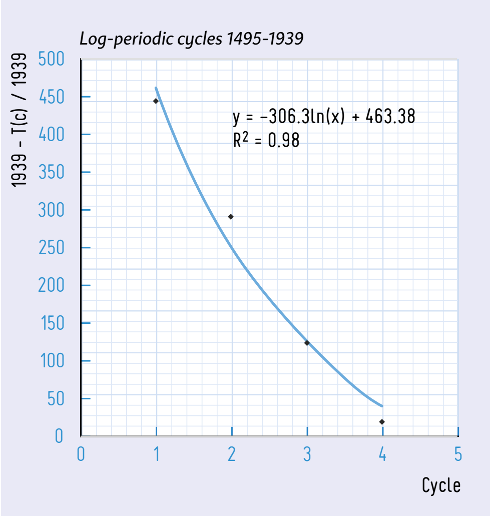
A closer look at the timing, as well as the duration, intensity, and severity, of successive systemic wars shows that systemic wars are highly regular and, as a consequence, predictable events. It is possible to identify four cycles (oscillations) during the 1495-1945 period. Each cycle consists of a relatively stable period that precedes a systemic war. During these relatively stable periods, the System is pushed toward the critical point, the next systemic war. Each systemic war produces an upgraded order (relatively stable period). The cycles accelerate. I argue that the singularity dynamic is driven by connectivity growth. The System reached a critical connectivity threshold (i.e., a singularity in finite time) in 1939 and, as a consequence, experienced a dual-phase transition.

Since the four cycles that accompanied the first finite-time singularity dynamic (1495-1939) are periodic in the logarithm of the variable (1939 - T(c)) / 1939) they are referred to as 'log-periodic.'

Log-periodic cycles: Acceleration in time (1495-1939)			
Cycle	T(c)	1939 - T(c)	1939 - T(c)/ 1939
1	1495	444	0.229
2	1648	291	0.150
3	1815	124	0.064
4	1918	21	0.011

Table 65 *The four cycles that accompanied the first finite-time singularity dynamic (1495-1939) are periodic in the logarithm of the variable (1939 - T(c)) / 1939) they are referred to as 'log-periodic.'*

Figure 78
Log-periodic cycles accompanied the first finite-time singularity dynamic (1495-1939).



It now is also possible to determine that the severities of the four successive systemic wars (that determine the amplitudes of the oscillations) follow the same periodic logic; see below table.

Log-periodic cycles: Acceleration of severities (1495-1939)			
Cycle	1939 - T(c)/ 1939 (1)	Severities actual SW's (2)	Severities theoretical SW's (3)
1	0.229	1,971,000	1,971,000
2	0.150	2,532,000	4,900,000
3	0.064	7,734,300	8,100,000
4	0.011	12,948,300	11,100,000
Correlation coeffecient:		(1) and (2): **-0.94**	(1) and (3): **-1.00**

Table 66 *The frequencies and amplitudes (severities in BCD) of the four cycles that accompanied the first finite-time singularity dynamic (1495-1945) were highly synchronized. SW stands for systemic war. This is additional proof for the coherence of the System's dynamics.*

066 Systemic war is synonym for criticality of the System; through systemic wars the order of the System is periodically upgraded; systemic wars consist of three overlapping processes/phases.

KEY WORDS *Systemic war, Criticality, Order, Phases, Issues, Tensions, Design, Upgraded order, Implementation.*

Systemic wars consist of three processes that partially overlap:

1 ***Destruction of dysfunctional issues and tensions***
During relatively stable periods, issues, states, and tensions crystalize into percolating vulnerable issue clusters. When these clusters percolate the System, the System becomes critical and produces a systemic war. The first process that typically unfolds during systemic wars is the destruction of dysfunctional issues and tensions that have over time accumulated in the System. What exactly is dysfunctional is decided by dominant powers that are (or become) in a position to achieve the required destruction.

2 ***Design of the upgraded order***
In an increasingly interdependent System, states also are increasingly dependent on each other for their mutual security. Order – a certain structural stability and acceptable tension levels – is necessary for states to be able to fulfill their basic requirements. The function of systemic wars is to establish upgraded orders that allow for a lower free energy state (lower tensions) and enable the fulfillment of basic requirements by uneven states in an anarchistic System, consistent with the second law of thermodynamics. In order to establish a viable upgraded order, states must bargain about

preferred options. States want to ensure that the arrangements that are embedded in the upgraded international order, promote their (specific) interests; dominant states are in the best position to enforce favorable international orders.

The second process concerns the design of the upgraded order that will be implemented. Through rules and accompanying institutions, privileges of dominant states are embedded in the arrangements of the upgraded international order; these rules for example prescribe how states are supposed to interact with each other. In the case of the fourth systemic war (The Second World War, 1939-1945), the designs (arrangements) of the new order in Europe and the first global order, were discussed in a series of high-level conferences in respectively Tehran (November- December 1943), Yalta (February 1945), and Potsdam (July 1945).

3 *Implementation of the upgraded order*

When the System crystallizes following a period of criticality (systemic war), the new order is implemented. This is a process that takes time and can result in new tensions and issues. The 'Berlin Blockade' (24 June 1948 - 12 May 1949) is a complication that arose during the implementation of the European and first global order, following the fourth systemic war (the Second World War, 1939-1945).

So far I have described this three-phased process from a contingent 'real world' perspective. From a deterministic 'energy' perspective, the (same) process can be described as follows: The System becomes critical when a vulnerable issue cluster with fractal structure percolates the System. This cluster contains issues and free energy (tensions) that are transformed into destructive energy. The free energy is deployed during criticality, to destroy dysfunctional issues and tensions *(Phase (1))*. The second law of thermodynamics determines that free energy will be put to work to implement an upgraded order that enables a lower energy state of the System; the destruction of dysfunctional issues is instrumental in this. A lower energy state of the System can be accomplished, if the actual centrality of nodes (Great Powers) in the System is re-aligned with the rule-sets that are embedded in the upgraded order (*Phase (2)*). By providing special rules – privileges – to nodes with a higher centrality (Great Powers), free energy production during the next relatively stable period (when the upgraded order is applied) is reduced, and interactions between states can be better regulated.

When the repositioning of nodes is finalized (*Phase (3)*) and the available free energy is put to work, the new order settles itself, and nodes resume their default interactions to fulfill their basic requirements and enable further growth.

During relatively stable periods, connectivity growth of the System continues and interactions between nodes unavoidably produce new free energy (tensions) that at a certain stage has to be put to work, to ensure the demands of the second law of thermodynamics are met.

067 System-size is not a decisive property for a war to qualify as systemic; during the first exceptional period (1657-1763) the System produced a number of system-sized non-systemic wars that do not qualify as systemic.

KEY WORDS *Sizes of wars, System size of wars, Non-systemic wars, Systemic wars, Criticality, Fractal structures, Degrees of freedom, Chaotic non-systemic war dynamics, Hyper-excited war dynamics, Subcritical.*

Systemic and non-systemic wars differ fundamentally in their properties and functions: through systemic wars the System implements upgraded (system-wide) orders that allow for a lower energy state of the System, and ensure its compliance with the second law of thermodynamics. Systemic wars typically are – and must be – system-wide to ensure all states are included in the upgraded order; if states – Great Powers – are excluded the upgraded order cannot be viable.

However, although systemic wars are by definition are system-wide, not all system-wide wars are systematic. During the exceptional period (1657-1763), the System produced two system-wide wars that do not qualify as systemic (war 75: War of the Austrian Succession, 1739-1748, and war 77, the Seven Years' War, 1755-1763) (38). When these system-wide wars were produced the System was not in a critical condition.

Criticality and systemic war are synonymous, and the effectiveness of systemic wars to design and implement upgraded orders is contained in the properties that characterize critical phenomena: a critical correlation length of 'one' and fractal structures. To achieve a system-wide effect, the size of a critical phenomenon needs to be system-wide.

The system-wide wars the System produced during the exceptional period can be attributed to the fact that the war dynamics of the System were determined by only two degrees of freedom (n) during that period of time.

As a consequence of the intense rivalry between Britain and France, the degrees of freedom were temporarily reduced from more than two ($n > 2$) to two ($n = 2$), causing the war dynamics to become temporarily periodic instead of chaotic. The neutralization of a third degree of freedom, a third state that states take into consideration regarding their war decisions, nullified the constraining effect of such a third variable (and of chaotic war dynamics). As a consequence, the non-systemic war dynamics of the System became more regular, but also more extreme; the System became hyper-excited.

The temporary decrease in the number of degrees of freedom caused issues between Britain and France to become over-connected, and the System became hyper-excited, leading to extreme tension levels and energy releases that were not constrained by a third degree of freedom. When $n = 2$, the System lacks built-in inhibition because the internal chaotic properties that normally constrain its dynamics were non-existent.

Beggs *et al.* (10) noticed a similar dynamic in brain activity; the similarities between the behaviors of the System and the brain could point to another case of universality regarding these types of networks. "... by blocking inhibitory synaptic transmission (*IP: equivalent to a reduction of the degrees of freedom of the System to two during the exceptional period*), it is possible to make the tissue (*IP: the System in this study*) hyper-exited, leading to larger avalanches (*IP: non-systemic wars*). (...) This looks like the supercritical phase, where activity is often amplified until it spans the entire system."

In 1763, when the rivalry between Britain and France was decided in favor of Britain, a third degree of freedom was again added to the System. Third states started influencing war decisions again. As the trajectories of the intensity and sizes of non-systemic wars show, the System resumed its chaotic – and more restrained – non-systemic war dynamics. The singularity dynamic also very quickly returned to its regular dynamic, ensuring the efficient development of the System towards criticality and a next systemic war.

068 Systemic wars required delicate balancing and posed a two-pronged threat to states: (1) the threat that unfavorable international orders would be imposed as a consequence of an unfavorable outcome of systemic wars, and (2) the threat that war efforts would cause internal imbalances because of their impact on the ability of states to ensure the balanced fulfillment of their basic requirements during these wars.

KEY WORDS *Systemic wars, Risks, Balance, Basic requirements, Collapse.*

Systemic wars are ordering forces and are manifestations of criticality of the System in the contingent domain. During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), systemic wars were produced at an accelerating rate and with accelerating severities (indicative for the destructive energy that was deployed).

States can only temporarily endure systemic wars; they required increasing amounts of resources for the production, mobilization, and deployment of destructive energy, and – at the same time – produced increasing levels of destruction on their own societies and populations. The increasing demands for (war) resources and increasing destruction impacted the ability of states to ensure the balanced fulfillment of all other basic requirements. In a number of cases, these conflicting demands caused internal imbalances for Great Powers and forced them to scale down their war efforts or risk collapse (Russia in 1917, Germany in 1918, the Eastern Hierarchy in 1989). The necessity to disengage, undermined bargaining positions of these states in the anarchistic System.

069 Destruction of tensions and issues in the System during systemic wars also is a highly-optimized and efficient process.

KEY WORDS *Systemic wars, Optimized destruction, Issues, Security dilemma, Interacting self-fulfilling prophecies.*

The optimized deployment of destructive energy during systemic wars is closely related to the structure of underlying vulnerable issue clusters that form during the relatively stable periods that precede these wars. Underlying vulnerable issue clusters, as well as systemic wars that emerge from these clusters when the System reaches a percolation condition, have fractal structures. Fractality of structures points to optimality I assume, and often concerns distribution processes these structures must perform; for example, distribution of energy.

Underlying vulnerable issue clusters concern the distribution of issues and tensions in the System and how they crystalized into fractal structures. During systemic wars, these fractal structures provide the infrastructure for the distribution of destructive energy.

Fractal structures of underlying vulnerable issue clusters, the fractal nature of systemic war activities, and the fractal structures of military organizations and capabilities are related phenomena that coevolved. Furthermore, I argue that the fractal structure of systemic wars carved out fractal state structures in the System. The size distribution of states in the System shortly before the critical connectivity threshold was reached can for that reason (and not coincidentally) - be best described by a power-law.

During relatively stable periods, states produced issues and tensions that crystalized into fractal vulnerable issue clusters; this process of 'storage' of free energy (tensions) and their crystallization, especially took place during high-connectivity regimes of relatively stable periods. These issues and tensions focus the preventive deployment of destructive energy. These deployments become integral parts of the issues and tensions, and eventually become equivalent. At a certain stage, preventive deployments of destructive energy, themselves, become issues.

At a certain point underlying vulnerable issue clusters percolate the System and the System becomes critical. Before the percolated vulnerable issue cluster can be triggered (a matter of short time, given the infinite susceptibility of the System in a critical condition), its structure already reflects the fractal structures of systemic war activities that will follow.

The formation of underlying vulnerable issue clusters during relatively stable periods is powered and shaped by connectivity growth, the security dilemma, and interacting self-fulfilling prophecies between states that are typically at work. Two positive feedback mechanisms, the security dilemma and interacting self-fulfilling prophecies, contribute to the optimality of systemic wars. They cause preventive destructive energy to be deployed at the right time, in the right place, and in the right amounts.

These two mechanisms interact as follows: During relatively stable periods, states deploy potential destructive energy in reaction to threats and tensions they perceive. Because of the security dilemma - implying that one state's security is another state's insecurity, this deployment often sets in motion a self-reinforcing process; deployments trigger new deployments, etc. This mechanism also constitutes a self-fulfilling prophecy. By causing counter-deployments, deployments of destructive energy confirm that the initial deployments were justified. In an anarchistic system it is easy to prove that your security concerns are valid concerns.

The two related mechanisms coordinate and highly optimize between states the coevolving deployments and counter-deployments of potential destructive energy by armies, navies, prepositioning stores, etc. As a result, issues, tensions, and related deployments of preventive energy become synonymous.

070 Systemic wars are worth fighting.

KEY WORDS *Systemic wars, Great Men.*

Through the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), upgraded orders – and ultimately dedicated non-anarchistic hierarchies – were step by step, 'war by war' implemented in the core of the System (Europe); only dedicated hierarchies provided viable 'solutions' that ensured compliance with the demands of the second law of thermodynamics.

The coevolution of deterministic and contingent dynamics unavoidably resulted in the establishment of increasingly powerful hierarchies.

Although systemic wars as such, 'Great Men in History' (highly influential individuals) and other contingent factors (and individuals), do not determine if dedicated hierarchies will and can be implemented – that is a prerogative of the second law of thermodynamics – they impact the 'nature' of the political and social structures of these hierarchies: systemic wars define dedicated hierarchies, the System and are worth fighting.

071 Destructive energy that must be deployed during systemic wars to implement upgraded orders is a function of the connectivity and size of the System.

KEY WORDS *Destructive energy, Systemic war, Structural stability.*

During systemic wars, issues and tensions must be destroyed to unfreeze the System and to allow for the design and implementation of upgraded orders. During systemic wars, rules of the System embedded in international orders and privileges are re-aligned with the actual centrality of states, as it has developed over time. The structural stability of international orders determines how much destructive energy must be deployed to allow for the implementation of upgraded orders. The structural stability of the System is a function of its connectivity.

Furthermore, the overall size of the System determines the amount of destructive energy that must be deployed: the larger the System the more destructive energy must be deployed.

3 INTRINSIC INCOMPATIBILITY

072 Increasing connectivity and security are intrinsically incompatible in anarchistic systems.

KEY WORDS *Intrinsic incompatibility, Connectivity, Security, Anarchy, Free energy.*

Increasing connectivity and security are intrinsically incompatible in anarchistic systems and result in the production of increasing levels of free energy (tensions). Each connection (potentially) adds to the ability of states (humans and populations) to fulfill their basic requirements, but in anarchistic systems, also (potentially) affect their security. Connectivity growth – increasing interdependence between states – always has a (potential) downside. It is just a matter of time before issues and tensions emerge in anarchistic systems, that are then further reinforced by the security dilemma and interacting self-fulfilling prophecies between states.

073 Interactions expose contradictions: In anarchistic systems interactions and the exposure of contradictions, result in tensions and issues that affect the (sense) of security of states and their populations.

KEY WORDS *Urge to survive, Interaction, Contradiction, Tensions, War, Finite-time singularity dynamic.*

States and populations in the System interact; the constancy in their interactions is the urge to survive, and the need to fulfill basic requirements to achieve this.

During interactions between states in anarchistic systems, contradictions between their basic requirements are exposed, that result in tensions (free energy).

Tensions (free energy) between units/states in anarchistic systems are caused by contradictions between the basic requirements of these units (states), and the need to fulfill these requirements to ensure their survival. The security dilemma – intrinsic to anarchistic systems – also reinforces contradictions between states.

Contradictions can be understood as ‘friction’; forces that resist cooperation and integration. The ‘degree’ of contradictions determine the level of incompatibility of the System. More, more frequent and more intense interactions increase the incompatibility of the System.

The amount of tensions (free energy) in the System and its rate of growth are a function of the level of incompatibility of the System, and the number, frequency and intensity of interactions between states.

Growth of populations of states in the anarchistic System and their increasing interdependence for fulfillment of their basic requirements, contribute to the number, frequency and intensities of interactions between states, and as a consequence to an increase in (the production of) tensions (free energy) in the System.

The same time as the production of tensions (free energy) in the System accelerated, the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), ensured a proper balance between order and disorder, and the optimal performance and evolvability of the System. By providing this optimal balance, the System ensured maximal growth of populations of states in the anarchistic System. The finite-time singularity dynamic, including wars that make up the singularity dynamic, and survival of (growing) populations of states are inseparably linked.

074 Connectivity is the control parameter of the System and feeds the singularity dynamic by producing free energy in the form of tensions.

KEY WORDS *Intrinsic incompatibility, Free energy, Tensions, second law of thermodynamics, Upgraded orders, Lower energy state.*

At the core of the dynamics of the System was (and still is) the intrinsic incompatibility between increasing connectivity (interdependence) and security in anarchistic systems. Population growth and rivalries between states in the anarchistic System were (and still are), the drivers of connectivity growth of the overall System, and of the underlying network of vulnerable issues clusters.

As a consequence of the intrinsic incompatibility between connectivity and security, and the growth of its connectivity, the System produced free energy; the free energy manifested itself trough as tensions in the domestic domain. Consistent with the second law of thermodynamics, tensions (free energy) were periodically put to work through systemic wars, to implement upgraded orders that allowed for a temporary lower energy state of the System.

075 Intrinsic incompatibility between connectivity and security in anarchistic systems results in the production of free energy (tensions) in the System; the second law of thermodynamics applies to the free energy, and its application – in combination with a number of other conditions – produced the finite-time singularity dynamics accompanied by four accelerating cycles, that during the 1495-1945 period unfolded in the System.

Key words: Intrinsic incompatibility, Connectivity, Security, Anarchy, Free energy, second law of thermodynamics, Singularity dynamic.

The intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems results in the production of free energy (tensions); the second law of thermodynamics also applies to free energy produced by the System.

Application of the second law of thermodynamics means that at a certain point, the free energy will be put to work to implement an upgraded order that enables a lower free energy state (lower tensions) in the System; a lower energy state of the System is functional – instrumental – in producing relatively stable periods, that allow states to fulfill their basic requirements, and further grow.

Because the connectivity of the System continued growing at an increasing rate, free energy (tensions) was also produced at an increasing rate. As a consequence, to ensure compliance with the second law of thermodynamics, upgraded orders had to be implemented at an accelerating rate. Because upgraded orders are - and only can be -implemented through systemic wars (critical periods), the anarchistic System produced systemic wars at an accelerating rate.

When the System in 1939 reached the critical connectivity threshold (the singularity in finite time), the System produced infinite amounts of free energy. The intrinsic incompatibility between connectivity and security had become 'absolute', infinite at that point.

The production of infinite amounts of free energy – tensions – was unsustainable, and as a consequence the anarchistic System collapsed; anarchy was no longer viable.

This unsustainable condition, that required systemic wars at an infinite rate and with infinite amplitudes (severities), could only be resolved by either reducing the connectivity of the System or by abandoning anarchy and changing the fundamental nature of the System.

Decreasing connectivity was not an option; on the contrary, the connectivity of the System – driven by population growth – was still accelerating. This left one option open to the second law of thermodynamics: neutralization of anarchy. Neutralization of anarchy was initially accomplished by implementing two dedicated non-anarchistic hierarchies in Europe: A Western hierarchy dominated by the United States and an Eastern hierarchy dominated by the Soviet Union. At a later stage, when the Eastern hierarchy collapsed in 1989, Eastern European states merged into the Western hierarchy.

076 Two options were (and still are) available to the System to solve the intrinsic incompatibility between increasing connectivity and anarchy, and ensure compliance with the second law of thermodynamics.

KEY WORDS *Intrinsic incompatibility, Connectivity, Security, Free energy, Anarchy, Phase transition, Security dilemma.*

In 1939 the core of the System reached the critical connectivity threshold. At that point, the incompatibility between connectivity and security in the anarchistic System had reached infinity. At that point, the core of the System produced infinite amounts of free energy (tensions) and systemic wars were as a consequence produced with an infinite frequency and infinite severities. The System could now no longer design and implement viable orders that could reconcile the intrinsic incompatibility between connectivity and security of the anarchistic System, and avoid the unsustainable amounts of free energy (tensions) that were produced. The core was now in a 'constant' condition of criticality, and if this condition was not resolved, the System would self-destruct. As a consequence of this condition the anarchistic System collapsed and produced a phase transition.

The phase transition presented a choice. The now infinite incompatibility between connectivity and security of the anarchistic could be solved in two ways: (1) by lowering the connectivity of the System, or (2) by abandoning anarchy and (by doing so) neutralizing the security dilemma.

Reducing connectivity, a property closely related to population growth and the need for humans and populations to fulfill their basic requirements and ensure their survival, was not a viable option, especially when it is taken into consideration that over time states had become increasingly interdependent to achieve fulfillment of their basic requirements.

The urge to survive of populations (and decision-makers that represented them) made states collectively 'choose' for implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe). By implementing these dedicated non-anarchistic hierarchies in respectively Western and Eastern Europe, anarchy was, at least within these hierarchies, abandoned, lowering the energy state of the System, consistent with the demands of the second law of thermodynamics.

077 In anarchistic systems, increasing connectivity goes hand-in-hand with increasing insecurity.

KEY WORDS *Connectivity, Interdependence, Incompatibility, Security, Anarchy, Free energy.*

The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) is a self-organized macro dynamic that emerged not by human-controlled design, but as the product of a multitude of interactions between states in the System. Through these interactions states and their populations ensured (or tried to ensure) adequate fulfillment of their basic requirements.

In the beginning, the fulfillment of basic requirements could be achieved independently of other states, but as a consequence of population and connectivity growth states became during the unfolding of the finite-time singularity dynamic increasingly dependent on each other, and on the arrangements they together designed and implemented in successive international orders that were related to their mutual security.

The singularity dynamic was highly path-dependent and locked-in on more and more integration and cooperation in the contingent domain of the System. Selection and self-organization led (1) to the selection of the state as the 'fittest' organizational structure that could ensure the fulfillment of basic requirements and survival of populations, and (2) to the coevolution of the state and successive international orders, these states periodically designed and implemented through systemic wars.

Ultimately, when in 1919 the anarchistic System reached the critical connectivity threshold, the System produced infinite amounts of free energy and collapsed as a consequence. During the dual-phase transition that followed, states and the international order in Europe partially merged, by implementing two dedicated non-anarchistic hierarchies.

Through these two dedicated non-anarchistic hierarchies, anarchy in these two hierarchies was neutralized, and the production of free energy (tensions) stopped.

078 'Connections' and interactions between states, their businesses and populations, provide (mutual) opportunities to exploit (new) economies of scale and scope; however, the same time as these opportunities present themselves, the increased connectivity (interdependence) of states also contribute to higher tension levels in the anarchistic System.

KEY WORDS *Singularity dynamic, Intrinsic incompatibility, Connectivity, Interdependence, Security.*

Connectivity is the driver of the System and of the finite-time singularity accompanied by four accelerating cycles (1495-1945). Population growth, increasing life spans of humans, and higher welfare expectations drive connectivity growth of the System.

Over time, during the development and unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the interdependence of states and their populations for the fulfillment of their respective basic requirements continuously increased. By connecting to and interacting with other states, states and their populations could more efficiently and effectively fulfill their basic requirements necessary for the survival of their (growing) populations.

However, connectivity and security in anarchistic systems are intrinsically incompatible; unavoidably, increasing connectivity (interdependence) leads to the production of increasing amounts of free energy (tensions).

At the same time as increasing connectivity provided opportunities and became more necessary to fulfill basic requirements of states, it also fueled rivalries between states that had to compete for resources in the anarchistic System. Rivalries contributed to the production of tensions and further powered the security dilemma. States, in other words, became more also interdependent in their mutual security requirements.

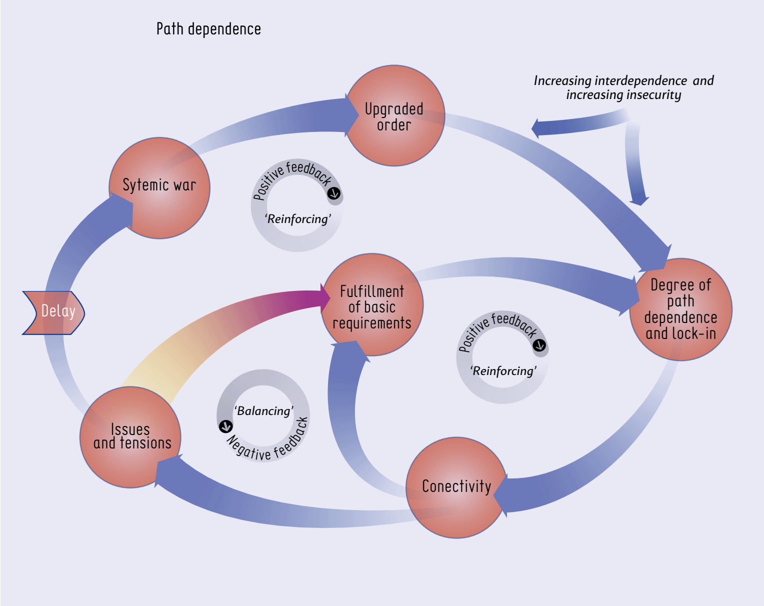


Figure 79 *This figure shows the relationships between variables in the System that produce a positive feedback mechanism that results in increasing path dependence and lock-in towards increasing interdependence of states and increasing levels of insecurity.*

079 Collapse of the anarchistic System could be avoided until the System in 1939 reached the critical connectivity threshold and produced infinite amounts of free energy (tensions).

KEY WORDS *Intrinsic incompatibility, Stagnation,Collapse.*

During the 1495-1945 period the System was periodically (four times) confronted with stagnation and collapse caused by dysfunction of its successive orders. In compliance with the second law of thermodynamics the singularity dynamic forced the System to implement 'organizational innovations' - upgraded orders - to avoid stagnation. The System maintained this innovation-dynamic (that is the singularity dynamic), until the System in 1939 reached a critical connectivity threshold, as a consequence collapsed, and then experienced a dual-phase transition. At that point, the incompatibility between increasing connectivity and security had become 'infinite', and the System could no longer find a viable order in the anarchistic System by just resetting its initial conditions and parameters.

080 Unsustainable requirements and effects caused the collapse of the anarchistic System, and a phase transition.

KEY WORDS *Singularity dynamic, Singularity in finite time, Unsustainable, Collapse, Critical connectivity threshold, Finite-size effects.*

A singularity is a mathematical 'concept' (idealization) where certain variables (properties) of a system reach infinity; accelerating growth rates (for example) cause infinite growth in finite-time. In real-world systems, as the finite-time singularity dynamic (1495-1945) shows, it is only a matter of time before, in the final phase of the singularity, the unsustainability of the increasing growth rates causes the System to collapse.

The collapse of the anarchistic System (when in 1939 the critical connectivity threshold – the singularity in finite time – was reached) resulted in a phase transition.

The unsustainability of the singularity dynamic is demonstrated by the infinite demands that the singularity dynamic made on states and the System shortly before its collapse in 1939. During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), systemic wars were produced with accelerating frequencies, as well as with intensities and severities that also grew at an increasing rate. I consider the intensity and severity of systemic wars as measures for the destructive energy that had to be (and was) deployed by the System to ensure the design and implementation of viable (upgraded) orders consistent with the second law of thermodynamics. During systemic wars, states deploy destructive energy to destroy issues and tensions, as well as to position themselves in the bargaining process where the next international order is designed.

The accelerating frequencies of cycles (systemic wars), and the accelerating growth rate of the amount of destructive energy that had to be deployed, could not be met physically or otherwise, and as a consequence the System in its final phase ('shortly' before its collapse in 1939) showed certain finite-size effects. It can be said that the practical limitations encountered by the singularity dynamic (to produce and deploy 'infinite' amounts of destructive energy) caused the collapse of the anarchistic System in 1939 and produced a necessary phase transition to ensure survival of states and their societies. The deployment of infinite amounts of destructive energy at a pace that, in fact, resembles a constant condition of war would also imply the (self-)destruction of the states that make up the System and of the System itself.

At the moment, states were confronted with the unsustainable demands of the singularity dynamic, decision-makers of states were confronted with a fundamental choice regarding the future of the System (and themselves): Continue following the war logic of the System, which would result in complete exhaustion and destruction, or accept another logic to regulate interactions between states. The urge to survive of states and societies enabled a phase transition toward a non-anarchistic system by implementing dedicated non-anarchistic hierarchies in the core of the System (Europe).

081 Wars in anarchistic systems have internal origins, and incidents in the contingent domain of the System only serve as triggers.

KEY WORDS *War, Intrinsic incompatibility, Energy releases, second law of thermodynamics.*

Wars in the anarchistic System – systemic as well as non-systemic – are energy releases that obey physical laws. Wars are manifestations of deterministic energy releases in the contingent domain of the System. Wars (energy releases) are intrinsic to anarchistic systems; the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems leads to the production of free energy; periodically, free energy has to be put to work, to ensure consistency with the 'demands' of the second law of thermodynamics.

'Incidents' only serve as triggers (in the contingent domain) to energy release events (wars).

A striking example of the internal origin of (systemic) wars and the working of incidents (triggers) is the assassination of Archduke Franz Ferdinand in June 1914 in Sarajevo; this incident did not cause the third systemic war (the First World War, 1914-1918) as is sometime suggested, but only served as a trigger for a systemic energy release.

At that point in time (June 1914), vulnerable issue clusters had percolated the System, caused it to become critical, and as a consequence highly susceptible for perturbations (as is typically the case for critical systems). Because of a correlation length of one during criticality (which explains the high susceptibility of the System), incidents can 'reverberate' through the System, and minor incidents can provoke systemic responses.

This means that if Archduke Franz Ferdinand was not assassinated around that time, another ('minor') incident would also have caused a systemic response (that is *the* third systemic war, and *a* – 'another' – First World War). Systemic energy releases – including a First World War – are unavoidable, given the internal dynamics of anarchistic systems. Sornette (regarding financial crashes) and Bak et al. regarding SOC-systems propose similar mechanisms for the systems they studied (3), (4), (5), (31), (63).

4 CONNECTIVITY AND ITS EFFECTS

082 Connectivity is the driver – the control parameter – of the system.

KEY WORDS *Connectivity, Control Parameter, Population growth, Two networks, Overall Network, Network of issues.*

The System I refer to is an integrated component of a much larger social network containing a multitude of nodes from individuals to the global system. Nodes are connected through a multitude of interactions, and often are 'clustered' in domains, that develop their own (domain-specific) dynamics.

Population growth is an important driver of various (sub)systems, networks and domains. Population growth implies that the total requirement for 'resources' to fulfill basic requirements increases; population growth also contributes to the rivalries between states in the System. Population size and growth, and connectivity (growth) are closely related phenomena.

Connectivity is the driver of the System. Connectivity growth feeds the intrinsic incompatibility between connectivity and security in anarchistic systems anarchy, and results in the production of free energy (tension) in the System.

It is possible to distinguish between two related networks (systems) and their respective connectivity's. Both networks and their connectivity growth impact the production of free energy in the System.

1 *Connectivity growth of the overall system*

Humans and social systems they (for various reasons) 'cluster' (organize) must fulfill basic requirements to ensure their survival. By clustering (forming groups, social systems, states, etc.) humans optimize the fulfillment of their basic requirements by leveraging economies of scale and scope. From a basic requirement and survival perspective, integration and cooperation have much to offer. Population growth results in increasing demands for (resources for) basic requirements. Population growth (and increasing demands it implies) also put higher demands on states to support their populations, and ensure the fulfillment of state-specific basic requirements. Finding 'balance' (internal and external) - through their integrative systems - also becomes more challenging for states, in case of growth.

During the unfolding of the finite-time singularity dynamic (1495-1945), states became increasingly dependent on other states for the fulfillment of their basic requirements. This became (increasingly) problematic because increasing connectivity (interdependence) and security in anarchistic systems unavoidably produced security issues and tensions (free energy). Security also is a basic requirement. The paradox is that while increasing connectivity between states allowed for a better fulfillment of basic requirements, at the same time it produced dysfunctional tensions that increasingly hindered the System's functioning (performance).

2 ***Connectivity growth related to the network of issues, states, and tensions in the System***

Issues, states, and tensions also form networks, mostly referred to here as '(underlying) vulnerable issue clusters'. These clusters also have a certain connectivity. The connectivity of this network of issues and states determined the sizes and frequencies of the non-systemic wars the System produced during relatively stable periods. Increasing connectivity of this network also goes hand-in-hand with increasing levels of free energy. The security dilemma, interacting self-fulfilling prophecies and rivalries between states further contribute(d) to the connectivity of the network of issues, and production of free energy (tensions) in the System. The moment the network percolated the System, the System became critical and produced a systemic war.

As mentioned both networks – (1) and (2) – are related.

083 Increasing connectivity impacts a number of dynamics and properties of the System.

KEY WORDS *Connectivity, Impact, Dynamics, Properties, Increasing Incompatibility, Low-connectivity regime, High-connectivity regime, Tipping point, Pace of life, Robustness, Fragility, Structural stability, Balance, Interdependence, Alliance dynamics.*

The following effects can be attributed to an increase in connectivity of the System:

Direct and indirect connectivity effects	
Effect	Explanation
Increasing incompatibility of the System.	Connectivity and security are intrinsically incompatible in anarchistic systems. Incompatibility produces the tensions and free energy that power the singularity dynamic.
Emergence of a tipping point in the non-systemic war dynamics during relatively stable periods of cycles, marking a switch from a low- to high-connectivity regime.	During relatively stable periods the connectivity of the System increases. The connectivity of the System determines the size and frequency of non-systemic wars the System produces. When the System reaches the tipping point of relatively stable periods states become more stable because of (what I name) the connectivity/stability-effect; from that point onwards, until the System becomes critical, the size of non-systemic wars the System can produce decreases. This effect primes the System for systemic war.
Increasing pace of life.	Population size determines the pace of life of the System. An increase in the pace of life also implies in increase in the speed of spreading phenomena, including the spreading speed of tensions and hostilities in the System.

Direct and indirect connectivity effects	
Increasing robustness and fragility.	Increasing connectivity of the System implies increased robustness and increased ability to absorb perturbations without producing non-systemic wars. Increasing robustness implies that the System's ability to produce free energy-release events (non-systemic wars) becomes increasingly limited/restrained. At the same time as the System's robustness increases, the fragility of the System (the ability of the System to maintain itself in a stability domain) decreases; robustness and fragility of the System are two sides of the same coin.
Increasing structural stability.	Connectivity increase also contributes to the structural stability of the System; its organizational stability (permanence) as well as the permanence (stability) of state-structures (form and size) in the System.
Increasing energy requirements of systemic wars to accomplish a rebalancing of the System through the implementation of upgraded orders.	Increased connectivity of the System impacts the energy required to rebalance the increasingly stable System.
Increasing interdependence.	Connectivity growth and growth of interdependence go hand-in-hand. Increasing interdependence has positive and negative effects in an anarchistic System. Positive: it improves the ability of states to fulfill certain basic requirements. Negative: it unavoidably produces issues and tensions that negatively affect the security of states, but also identities of humans and social systems.
Increasing alliance dynamics.	Increasing connectivity results in (more) issues and tensions in the System; in response states try to hedge certain risks by forming alliances.

Table 67 *This table shows and explains the most obvious connectivity effects.*

084 The connectivity of the System determines the sizes and frequencies of non-systemic wars during relatively stable periods (international orders) that precede systemic wars. A tipping point marks the boundary between low- and high-connectivity regimes; during high-connectivity regimes free energy (tensions related to unresolved issues) is temporarily stored in the System to be released during the next systemic war.

KEY WORDS *Connectivity, Low-connectivity regime, High-connectivity regime, Sizes non-systemic wars, Frequencies non-systemic wars, Energy storage, Crystallization, Percolation, Vulnerable issue clusters, Criticality, Systemic war.*

During relatively stable periods, the connectivity of the System, including the network of states and issues and the underlying vulnerable issue clusters, increases continuously. Directly following a systemic war, the connectivity of the network of issues still is limited. At that stage, an increase in connectivity implies an increase in the size of non-systemic wars (non-systemic energy releases). However, when a tipping point is reached, marking the switch from a low- to a high-connectivity regime, the size of non-systemic wars starts decreasing as a consequence of increased local stability of the nodes (states) of the System, produced by their increasingly high-connectivity.

Because of the high-connectivity effect, the ability of the System to release free energy is (increasingly) reduced, and instead of being released, this energy (tensions) is then stored in the System. The 'stored' free energy (tensions) crystallizes in underlying vulnerable issue clusters. The moment these underlying vulnerable issue clusters become connected – a matter of time because of the accelerating amounts of free energy (tensions) the anarchistic System produces – and percolate the System, the System becomes critical and produces a systemic war. Through these systemic wars – consistent with the demands of the second law of thermodynamics – the System implements upgraded orders, that are better able to regulate increasing amounts of free energy in the System; upgraded orders allow for a lower energy state of the System. A lower energy state of the System – lower tensions – are a precondition for states to fulfill their basic requirements.

085 Connectivity is the driver of the System.

KEY WORDS *Connectivity, Driver, Acceleration, Pace of Life*

The condition of 'nodes' (states) in the issue network (i.e., the preparedness of states to go to war) is at the heart of the war dynamics of the System. Properties of the network of states and issues, along with the preparedness of these states to engage in war, determine the size and frequency of wars. As Schläpfer et al. pointed out, connectivity of the network in terms of degree and communication activity, is a key factor that determines the spreading speed of information. I assume that the connectivity of the System also determines the spreading speed of tensions, (perceived) threats, and hostility in the System. By doing so, connectivity determines the condition of states and their preparedness to engage in war interactions. In other words, the connectivity of the System determines the 'pace of life' of the System, including properties like the frequency of systemic wars. The connectivity of the System determines its 'pace': increasing connectivity contributes to the acceleration of the frequency of successive systemic wars and, in so doing, determines the acceleration or shortening of life spans of successive cycles (i.e., the relatively stable periods and the systemic wars) that follow.

To test the consistency of the assumption that connectivity sets the pace of life, I further analyzed the life spans of the four cycles (oscillations), as well as of the components of successive cycles, namely of successive relatively stable periods and accompanying systemic wars. The results are shown in the table 65 and figure 78.

Analysis shows that the life spans of successive relatively stable periods and accompanying systemic wars shortened by an identical accelerating rate.

This result supports the assumption that the same mechanism, I propose the connectivity of the System, determines the life span of both phenomena (of relatively stable periods and accompanying systemic wars).

However, a closer look also reveals that the life span of the fourth systemic war (the Second World War, 1939-1945) causes a distortion: the life span of the Second World War is too long when the logic I just proposed is consistently followed.

If the life spans of the first three systemic wars are extrapolated (assuming a consistent rate of acceleration), the life span of the fourth systemic war (the Second World War) would have been ≈ 2.5 years.

This distortion can be explained as follows: the fourth systemic war was not a 'normal' systemic war because this particular systemic war constituted a 'dual' phase transition: Through the fourth systemic war dedicated non-anarchistic hierarchies were implemented in Europe (the core of the System), and at the same time a first global order at a global scale of the System. The fourth systemic war in fact was the 'first world war' and not just in name. The 'global component' of the fourth systemic war impacted on its duration.

In other words, the life span of the fourth systemic war would have been about 2.5 years if the global component of this war is excluded.

086 A low- and a high-connectivity regime divided by a tipping point can be identified in the non-systemic war dynamics of the System during relatively stable periods. The connectivity of the network of issues and states defines a war window.

KEY WORDS *Low-connectivity regime, high-connectivity regime, War window, Sizes of wars.*

The finite-time singularity dynamic (1495-1945) was accompanied by four accelerating cycles; each cycle typically consisted of a relatively stable period followed by a systemic war. Each relatively stable period starts with a low-connectivity regime; in low-connectivity regimes the connectivity of the network of issues and states determines the size and frequency of wars the System produces. Increasing connectivity during the low-connectivity regime implies increasing war sizes.

Once the tipping point of relatively stable periods is reached, the System enters a high-connectivity regime. In high-connectivity regimes, the sizes of non-systemic wars decrease, because of the increasing connectivity of states in the network of issues and states, and local stabilities this results in. In high-connectivity regimes, the effect of new signals, for example positive war decisions by other states, become less significant. In high-connectivity regimes – between the tipping point and the moment the System becomes critical – non-systemic war dynamics (almost) come to a halt.

In high-connectivity regimes during relatively stable periods (international orders), free energy (tensions) that still builds up in the System is – and cannot – be released, and is instead temporarily 'stored' in the System and crystallizes in underlying vulnerable issue clusters. When these underlying vulnerable issue clusters percolate the System, the System becomes critical and produces a systemic war.

A lower and an upper boundary limit both regimes I just described. It is possible to distinguish a lower boundary, that defines when the System was sufficiently connected to produce non-systemic wars (1495), and an upper boundary that defines when wars became impossible because of the ('too') high connectivity of the System.

The upper boundary was reached when the anarchistic System in 1939 became – as a consequence of its high connectivity – 'infinite' robust (and could not produce non-systemic wars anymore), collapsed, and produced two dedicated non-anarchistic hierarchies in the core of the System (Europe).

The lower and upper boundary define a window that I refer to as the 'war window' of the anarchistic System (1495-1945), in which the connectivity of the anarchistic System enables energy releases in the form of wars.

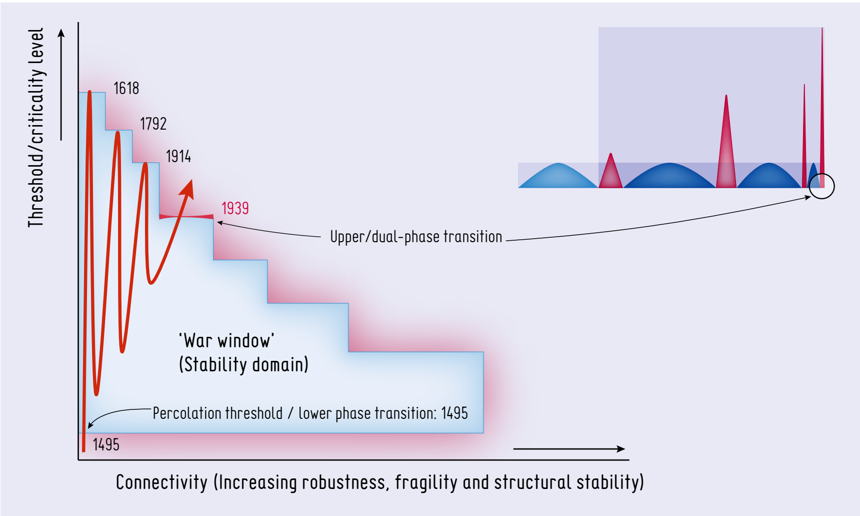


Figure 80 *This figure shows, what I denote as a 'war window' (based on the 'cascade window' constructed by Watts (72)). The System needs to be 'within' the war window, defined by the connectivity of the issue network and thresholds used by states to decide to go to war (or not), to be able to produce wars (war dynamics). In 1495 the System reached the percolation threshold (lower phase transition) of the war window. During the period 1495-1939, the System oscillated 'within' the war window. In 1939, the System reached the upper phase transition (critical connectivity threshold), and by means of the fourth systemic war (the Second World War, 1939-1945), the core of the System (Europe) was 'pushed' into another stability domain. The three preceding systemic wars ensured that the System was still able to 'find' a lower energy state (consistent with the second law of thermodynamics) within an anarchistic context. This is above all a schematic approach to the war dynamics of the System, that does however not fully comply with the behavior of the System.*

087 Abundant evidence is available that supports the hypotheses that low- and high-connectivity regimes can be distinguished during successive relatively stable periods. Tipping points can be identified in non-systemic war dynamics during relatively stable periods.

KEY WORDS *Low-connectivity regimes, High connectivity regimes, Tipping point.*

Based on visual analysis of the war data provided by Levy (38), I identified if and when the size of non-systemic wars during the relatively stable periods started to decrease. In the table below, I show the three tipping points of the respective relatively stable periods (international orders). It is not possible to identify a tipping point during the fourth, very short, international order (1918-1939), for the simple reason that during this period only two ('European') non-systemic war took place.

Tipping Points of international orders during relatively stable periods (1495-1945)

International order	Period	Tipping Point
1	1495 - 1618	1514
2	1648 - 1792	1774
3	1815 - 1914	1856
4	1918 - 1939	Not applicable

Table 68 *This table shows the tipping points of the first three relatively stable periods (international orders) of the first finite-time singularity dynamic (1495-1945).*

088 Low- and high-connectivity war cluster can be defined for each relatively stable period (international order).

KEY WORDS *Low-connectivity regime, High-connectivity regime, Tipping point, War clusters, Properties.*

I defined six war clusters – a low- and high-connectivity war cluster during each relatively stable period (international order) – that include non-systemic wars that at least involved two Great Powers. These clusters should reveal some regularities, if low- and high-connectivity regimes during relatively stable periods (international orders) are not mere 'artefacts'; theoretical constructs without any meaning.

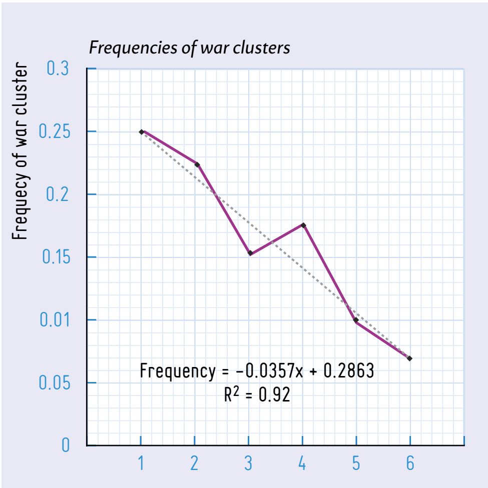
The table below shows the number of non-systemic wars that can be distinguished in each of the six clusters. The table also shows the average size and the war frequency of each cluster.

Identification and properties of war clusters. Data from Levy (38)								
	Low-connectivity war clusters				High-connectivity war clusters			
Int. order	Cluster	Nr. of wars	Average size	Frequency	Cluster	Nr. of wars	Average size	Frequency
1	1	2	0.560	0.250	2	25	0.473	0.223
2	3	19	0.534	0.151	4	3	0.389	0.176
3	5	4	0.483	0.098	6	4	0.392	0.070

Table 69 *This table shows six war clusters and some of their properties that can be distinguished during the first three relatively stable periods (international orders), including the number of non-systemic wars each cluster produced between Great Powers, and their average size and frequency. Size is defined in terms of the fraction of Great Powers participating in a war divided by the total number of Great Powers in the System at that moment in time; it is a relative measure.*

Figure 81
This figure shows the average size (defined as fraction) of six war clusters that can be distinguished during the first three relatively stable periods (international orders). Orders 1-2, 3-4, and 5-6 respectively concern the first (1495-1618), second (1648-1792) and third (1815-1914) relatively stable periods (international orders). War clusters 1, 3, and 5 are low-connectivity clusters; 2, 4, and 6 represent high-connectivity clusters. Data from Levy (38).

Figure 82
This figure shows the frequencies of non-systemic wars (number of wars divided by the life span of the cluster) during six war clusters that can be distinguished during the first three relatively stable periods (international orders). Orders 1-2, 3-4, and 5-6 respectively concern the first (1495-1618), second (1648-1792) and third (1815-1914) relatively stable periods (international orders). War clusters 1, 3, and 5 are low-connectivity clusters; 2, 4, and 6 represent high-connectivity clusters. Data from Levy (38).



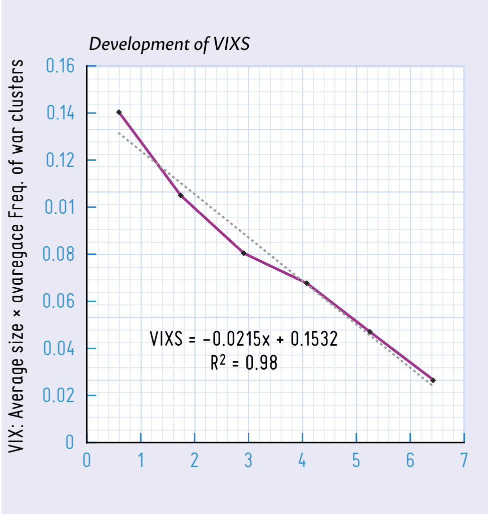
Based on this perspective – the identification of low- and high-connectivity war clusters during successive relatively stable periods (international orders) – it is possible to make a number of observations.

1) **The average size of successive war clusters developed in accordance with theoretical predictions**. The average size of war clusters developed predictably:
a During each relatively stable period (international order), the average size of wars during low-connectivity regimes was larger than during high-connectivity regimes.
b The average size of wars during low-connectivity regimes of successive international orders decreased consistently.
c The average size of wars during high-connectivity regimes of successive international orders is distorted: The average size of wars during the high-connectivity regime of the second relatively stable period (second international order, 1774-1792) that followed the first exceptional period (1657-1763) was lower. I propose that this was a consequence of the series of exceptionally large abnormal non-systemic wars the System produced during the exceptional period that preceded it.
d The overall size of war clusters decreased, pointing to increasing local stability of the System, consistent with the continuous increases of the connectivity of the System.

2) **The frequencies of successive war clusters developed in accordance with theoretical predictions**. Apart from a distortion caused by the third and fourth war clusters that constitute the second relatively stable period (second international order, 1648-1792) that includes the first exceptional period (1657-1763), the frequencies of successive war clusters decreased regularly. I propose that, without the distortions caused by the abnormal non-systemic war dynamics during the first exceptional period (1657-1763), the decreases would be linear. During the first exceptional period (1657-1763) the second relatively stable period (the second international order, 1648-1792) was (and continuously stayed) in its low-connectivity regime (1648-1775). This figure suggests that the System produced a lower, respectively a higher number of non-systemic wars during the low- and high connectivity regimes of the second relatively stable period, because of the abnormal non-systemic war dynamics during the exceptional period.

3) **The volatility index of the System (VIXS) of war clusters in the System decreased linearly**. I define the volatility of war clusters as the product of the average size of a war cluster and its war frequency: VIXS (war cluster) = average size × frequency. The VIX decreased linearly.

Figure 83
This figure shows the development of the volatility index of the System (VIXS) during the first three relatively stable periods (international orders): The VIXS decreased about linearly, suggesting that distortions in the average size and frequencies of war clusters were 'leveled out' (corrected). Orders 1-2, 3-4, and 5-6 respectively concern the first (1495-1618), second (1648-1792) and third (1815-1914) relatively stable periods (international orders). War clusters 1, 3, and 5 are low-connectivity clusters; 2, 4, and 6 represent high-connectivity clusters. Data from Levy (38).



The linear decrease of the VIX suggests that distortions in the frequencies and average sizes of war clusters compensated each other: It seems that underlying deterministic energy laws corrected the impact of contingent variables.

089 Increasing connectivity of the System resulted in an accelerating growth rate of free energy (tensions) the anarchistic System produced. Increasing connectivity forced the System to put increasing levels of free energy to work at an accelerating pace. These conditions set an additional premium on the ability of states to produce, mobilize, and deploy destructive energy.

KEY WORDS *Connectivity, Acceleration, Free energy, Destructive energy deployment by states.*

As a consequence of the intrinsic incompatibility between connectivity and security in anarchistic systems, continuous growth of the connectivity of the System, resulted in the production of accelerating amounts of free energy (tensions). To ensure compliance with the second law of thermodynamics, the accelerating amounts of free energy had to be put to work through systemic wars that were (and had to be) produced at an accelerating rate, and with accelerating amplitudes (severities).

The fact that successive relatively stable periods (international orders) were increasingly robust, and could at a certain point, shortly before in 1939 the critical connectivity threshold was reached, not any longer release free energy (tensions) through non-systemic wars, also contributed to the acceleration of cycles. Eventually all free energy (tensions) could only be released through systemic war.

This accelerating dynamic – as the second law of thermodynamics required – was vital for the development and unfolding of the finite-time singularity dynamic (1495-1945) and required the ability of states to produce and deploy accelerating amounts of destructive energy. During the unfolding of the finite-time singularity dynamic, accompanied by four accelerating cycles (1495-1945), Europe not only transformed from a sizeable collection of loosely coupled and diverse units into a coherent and highly connected System of standardized states, but states also continuously had to improve their ability to produce and deploy destructive energy; state became increasingly 'tuned' to fighting more destructive and more total wars.

090 High-connectivity regimes during relatively stable periods are a prerequisite for the anarchistic System to become critical, to produce systemic wars, and to be able to implement upgraded orders.

KEY WORDS *High-connectivity regime, Chaotic war dynamics, Free energy release deficit, Crystallization, Criticality.*

During relatively stable periods, the System experiences respectively a low- and a high-connectivity regime. Typically, during high-connectivity regimes, the increasing connectivity of the network of issues and states in the System resulted in increasing local stability of its nodes (states); as a consequence, the sizes of non-systemic wars decreased; almost to 'zero', shortly before the outbreak of the next systemic war.

The increased local stability of the System during high-connectivity regimes impacted the ability of the System to release free energy (through systemic wars). Although free energy (tension) was produced at an increasing rate, its release through non-systemic release events decreased at the same time. Instead of being released, tensions were 'stored' in the System (and produced a 'free energy release deficit' in the form of unresolved tensions), and crystallized in vulnerable issue clusters with fractal structures.

The moment the vulnerable issue clusters percolated the System (and the correlation length of the vulnerable issue cluster had become one), the System had become critical and produced a systemic war; consistent with the second law of thermodynamics free energy (tension) was put to work (through systemic wars), to implement an upgraded order that would allow for a lower energy state of the System. The typical characteristics of the System in a critical condition, the ability for system-wide communication, coordination, and planning, meant that upgraded system-wide orders could then be implemented.

A lower energy state and relative structural stability are equivalent; a relatively stable period enables the continued fulfillment of basic requirements of states in the System.

High-connectivity regimes during relatively stable periods are an essential pre-condition for systemic wars, the implementation of upgraded order and further development of an anarchistic system.

091 Connectivity (growth) impacts on energy transfers in the System.

KEY WORDS *Connectivity, Energy.*

The connectivity/stability effect during high-connectivity regimes of relatively stable periods impacts the energy transfers in the System by depriving the System of the ability to release free energy through non-systemic wars (non-systemic release events). The increasing local stability of states during high-connectivity regimes enables the build-up and storage of free energy as issues and tensions that cannot be resolved. The unreleased free energy crystalizes in vulnerable issue clusters that eventually percolate the System. At that point the System has become critical, its correlation length is one, and its susceptibility is infinite. At that stage, any event or incident will trigger a massive systemic energy release in the form of a systemic war. From an energy-transfer perspective, three phases can be distinguished:

1) **Phase I, during low-connectivity regimes of relatively stable periods**. Free energy is released through non-systemic energy releases. The size of these releases is dependent on the connectivity of the System; an increase in connectivity during the low-connectivity regime implies an increase in energy releases; an increase in the average size of non-systemic wars.

2) **Phase II, during high-connectivity regimes of relatively stable periods**. Free energy is released through non-systemic energy releases; the size of these releases is progressively restricted by the increasing local stability of states in the System. During the high-connectivity regime, increasing connectivity produces increasing local stability; this local stability not only restricts the sizes of non-systemic energy releases, but also increases the System's ability to store free energy. The free energy release deficit that builds up during this phase contributes to the formation and eventual percolation of vulnerable issue clusters. These clusters are manifestations of unresolved issues and tensions. A tipping point separates low- and high-connectivity regimes of relatively stable periods.

3) **Phase III, during criticality**. Once vulnerable issue clusters that have been building up and crystallizing during high-connectivity regimes become connected and percolate the System, the System has become critical. Criticality of the System is equivalent to and implies an systemic energy-release of the System, that manifests itself as a systemic war. During systemic wars, free energy is put to work to implement upgraded orders that allow for a lower free energy state of the System.

092 The connectivity of relatively stable periods determines the System's level of metastability.

KEY WORDS *Singularity dynamic, Low-connectivity regime, High-connectivity regime, Metastability, Free energy storage, Crystallization, Acceleration.*

The ability of the System to spend an extended time in a configuration other than the System's state of least energy, determines its level of metastability.

The development and unfolding of a finite-time singularity dynamic accompanied by four accelerating cycles in the anarchistic System during the 1495-1945 period, was a self-organized response to the accelerating amounts of free energy (tensions) states in the anarchistic System produced, and of the 'application' of the second law of thermodynamics to this free energy.

Each cycle of the singularity dynamic consisted of a relatively stable period, followed by a systemic war. Through systemic wars, the System produced international orders, to ensure that uneven states in the anarchistic System could collectively fulfill their basic requirements.

It is possible to distinguish between two regimes during relatively stable periods (the life span of international orders): a low- and high-connectivity regime respectively, divided by a tipping point.

Initially, following a systemic war (that had resulted in the implementation of the 'new' upgraded international order), the connectivity of the network of issues in the System – as well as the sizes of non-systemic energy releases (releases of tensions through non-systemic wars) the System produced – were still limited. During low-connectivity regimes of international orders, increasing connectivity implies an increase in the sizes of non-systemic wars. I assume that the energy state during low-connectivity regimes of international orders is low, as well as the level of metastability of the System.

However, the moment international orders reach their respective tipping points, a connectivity/local stability effect starts restricting the sizes of non-systemic wars (non-systemic release events) the System can produce; while at the same time, the System produces increasing amounts of free energy (tensions). The connectivity/local stability effect during high-connectivity regimes can be attributed to the increasing local stability of states, caused by the increasing connectedness of the network of issues, they are integral parts of. During high-connectivity regimes, instead of being released, tensions and unresolved issues are 'stored' in the System, form a free energy release deficit and crystallize in vulnerable issue clusters with fractal structures.

I assume that the energy state of the System – the level of metastability – during high-connectivity regimes of international orders constantly increases, until the moment when a critical limit is reached. The limit is reached when vulnerable issue clusters percolate the System, cause the System to become critical and produce a systemic war.

During systemic wars, the free energy (tensions) that has amassed in the System (the free energy release deficit) is put to work, to implement upgraded orders that (again) allow for a lower energy state in the System. The lower energy state is 'contained' in the new (upgraded) international order that is implemented, and allows states in the anarchistic System to fulfill their basic requirements (again).

Thus, two developments can be observed regarding the level of metastability of the anarchistic System during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945); first an increase of the energy state – the level of metastability – of the System during high-connectivity regimes of international orders, and second, an 'overall' increase in metastability during successive international orders, that are increasingly better able to endure a higher energy state. However, despite the overall improvement of successive international orders to restrain increasingly higher energy states, they were increasingly short-lived; the accelerating growth rate of free energy (tensions) outpaced the System's ability to achieve sufficient (meta)stability to survive in an anarchistic context.

093 Connectivity drives the dynamics and development of the System.

KEY WORDS *Connectivity, War dynamics, Development, second law of thermodynamics, Energy storage, Intrinsic incompatibility, Security, Anarchy, Robustness, Local stability, Fragility.*

The amount of free energy (tensions in the contingent domain) the System produces and when, where, and how much free energy is released or stored, are determined by the connectivity of the System and the second law of thermodynamics to which free energy has to comply. The connectivity of the System determines the amount of free energy that is produced as a consequence of intrinsic incompatibility between connectivity and security in anarchistic systems. The connectivity of the System also determines the structural stability and the robustness of the System. Structural stability and robustness, and the regime a relatively stable period is in (a low- or high-connectivity regime), determine how much energy can be released through non-systemic wars, and how much energy can be temporarily stored in the System until the System unavoidably becomes critical (as a consequence). 'Stored' free energy and free energy that will be produced once the System has become critical are put to use during systemic wars to implement upgraded orders and to ensure the System's compliance with the second law of thermodynamics.

The accelerating rate at which free energy was produced caused successive orders to be increasingly short-lived. When the System reached the critical connectivity threshold (the singularity in finite time, 1939) it produced infinite levels of free energy (tensions). At that point, the robustness and structural stability of the System were absolute, but the System became infinitely fragile (unstable). This condition was unsustainable. The anarchistic System could not provide new solutions in the form of upgraded orders that could contain the infinite levels of free energy. The anarchistic System collapsed and experienced a phase transition that led to the implementation of dedicated hierarchies, consistent with the demands of the second law of thermodynamics.

094 In the final stages of high-connectivity regimes of relatively stable periods, shortly before the anarchistic System becomes critical and produces systemic wars in response, the System is highly stable.

KEY WORDS *High-connectivity regime, Local stability, Deterministic domain, Energy storage, Crystallization.*

I argue that two regimes can be distinguished during the life cycle of relatively stable periods: a low- and a high-connectivity regime, respectively. During high-connectivity regimes the sizes of non-systemic wars are increasingly inhibited because of the increasing connectivity of states in the network(s) of issues that develop in the System. During high-connectivity regimes, instead of being released, tensions are stored in the System and crystallize in vulnerable issue clusters, of which states are integral parts. The moment these clusters percolate the System, the System becomes critical and produces a systemic war.

The increasing local stability of states, and decreasing sizes of non-systemic wars, shortly before the System becomes critical, is however misleading; it just is a matter of time before a systemic war breaks out; such a war in fact is imminent.

Watts (72), (73) describes the typical behavior – when the System has reached the upper boundary of the war window (as I characterize this condition) – as follows: "Here, the propagation of cascades is limited not by the connectivity of the network, but by the local stability of the vertices," where vertices are node states in the System. (…) "A percolating vulnerable cluster, however, still exists, so very rarely a cascade will be triggered in which case the high connectivity of the network ensures that it will be extremely large." This cascade is a systemic war.

At this stage, Watts explains: "… the system will in general be indistinguishable from one that is highly stable, exhibiting only tiny cascades for many initial shocks before generating a massive, global cascade in response to a shock that is *a priori* indistinguishable from any other."

Because this typical dynamic concerns the deterministic domain, Clark and other historians still have difficulty making sense of the last two pre-war years (1912-1914), "… one of the most curious features of the last two pre-war years, namely that even as the stockpiling of arms continued to gain momentum and the attitudes of some military and civilian leaders grew more militant, the European international system as a whole displayed a surprising capacity for crisis management and détente" (18). This curious feature can now be made sense of.

095 During the high-connectivity regime of the third international order (1815-1914), vulnerable issue clusters – of which states are integral parts – constantly expanded and became increasingly connected.

KEY WORDS *High-connectivity regime, Third International order, First World War, Security dilemma, Interacting self-fulfilling prophecies.*

Clark (18) describes how events became connected and tightly coupled leading up to the outbreak of hostilities in August 1914: "By the spring of 1914, the Franco-Russian Alliance had constructed a geopolitical trigger along the Austro-Serbian frontier. They had tied the defense policy of three of the world's greatest powers to the uncertain fortunes of Europe's most violent and unstable region... But since they viewed their own actions as entirely defensive and ascribed aggressive intentions solely to the enemy, the key policy-makers never took seriously the possibility that the measures they were themselves enacting might be narrowing the options available to Berlin. It was a striking example of what international relations theorists call the 'security dilemma', in which the steps taken by one state to enhance its security 'render the others more insecure and compel them to prepare for the worst.'"

This dynamic demonstrates how the security dilemma and interacting self-fulfilling prophecies worked in practice, and how issues and states increasingly became tightly coupled. The arrangements between states to which Clark refers, became integral components of vulnerable issue clusters, that eventually percolated the System caused it to become critical, and produce the third systemic war (the First World War, 1914-1918).

096 Abnormal non-chaotic war dynamics during the second relatively stable period (the second international order, 1648-1792) show that chaotic non-systemic war dynamics are (1) a prerequisite for relatively stable periods (the System) to reach the high-connectivity regime, and (2) a prerequisite for the System to produce a free energy release deficit, produce vulnerable issue clusters with fractal structures, and to become critical.

KEY WORDS *Singularity dynamic, Performance, Evolvability, Optimization, Chaotic dynamics, Exceptional period, Period war dynamics, Low-connectivity regime, High-connectivity regime, Tipping Point, Criticality.*

The finite-time singularity dynamic accompanied by four accelerating cycles that developed and unfolded in the anarchistic System during the 1495-1945 period, was a highly optimized dynamic, that ultimately resulted in the simultaneous implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and the first global order at a global scale of the System, through a dual-phase transition (the fourth systemic war, the Second World War, 1939-1945).

During its unfolding the finite-time singularity dynamic ensured an optimal 'balance' between the performance of the System and its evolvability; the singularity dynamic in fact, enabled population growth in Europe – under anarchistic conditions – from 83 million in 1495 to 544 million in 1945.

This study shows, that for the anarchistic System to be able to evolve – to implement 'functional' and viable upgraded (international) orders (that ensure its performance) – non-systemic war dynamics (wars during relatively stable periods) must be chaotic in nature; to put it somewhat more dramatic: chaos is a prerequisite for 'new' order (see also (20))

The 'impact' of non-chaotic non-systemic war dynamics during the first exceptional period (1657-1763), during the second relatively stable period (second international order, 1648-1792) reveal this phenomenon. During this period the non-systemic war dynamics of the System were not chaotic, but periodic instead; an 'effect' that can be attributed to the impact of the intense rivalry between Britain and France had (during that period) on the number of degrees of freedom (n) in the System.

Analysis shows that chaotic non-systemic war dynamics (n > 2) are more balanced – more constrained – than periodic war dynamics (n = 2) the System produced during the first exceptional period (1657-1763). A third degree of freedom (a third variable, a third state that is taken into consideration regarding war decisions), has an inhibitory effect. In case the System lacks a third degree of freedom, issues in the System are 'simplified', and are only defined by the intense rivalry between two Great Powers, as was the case during both exceptional periods.

In case of the first exceptional period, issues became over-connected, and non-systemic war dynamics became more extreme (their size and severities) as a consequence; the System became temporarily 'over-excited'. The trajectories of non-systemic wars in phase state (defined by size and intensity) show the fundamental different behavior between chaotic and non-chaotic non-systemic war dynamics.

The typical behavior of the System during the second relatively stable period (1648-1792) - the (change in the) nature of non-systemic war dynamics, and its effects on the unfolding of the singularity dynamic - cannot be understood without taking the two different regimes of relatively stable periods into consideration.

During the life span of relatively stable periods (international orders) - including the second relatively stable period - it is possible to distinguish two 'connectivity' regimes, respectively a low- and a high-connectivity regime, divided by a tipping point.

The 'connectivity' I refer to, concerns the connectivity of the issue-network of the anarchistic System, of which states are integral parts.

During low-connectivity regimes (the regime that typically follows systemic wars), the connectivity of the network of issues in the System still is limited, and increasing connectivity of the issue network, results in increasingly larger sized non-systemic wars. However, once the tipping point of the relatively stable period is reached – during high-connectivity regimes –

increasing connectivity of the issue network results in increasingly smaller sized non-systemic wars. This effect, I also refer to as the connectivity/local stability effect, can be attributed to the fact that states (once the tipping point is reached) become increasingly 'stable'; because of the high connectivity of the issue network (of which states are integral parts), each new incoming signal (a new issue states are confronted with) loses significance, and states do not 'easily' switch to positive war decisions.

When the System reaches the tipping point of a relatively stable period, the System still produces accelerating amounts of free energy (tensions); but as a consequence of the connectivity/local stability effect this free energy cannot be (completely) released, and is instead 'stored' in the System. The stored energy (tensions) forms a free energy release deficit, and crystallizes in vulnerable issue clusters with fractal structures. Once these vulnerable issue clusters percolate the System, the System becomes critical, and produces a systemic war to upgrade the order of the System.

I argue that the System can only become critical, produce systemic wars, and further develop (by implementing upgraded orders), if the System reaches the high-connectivity regime of the relatively stable period, and when its non-systemic war dynamics are chaotic in nature.

The periodic non-systemic war dynamics during the first exceptional period (1657-1763), were produced when the second relatively stable period (second international order, 1648-1792) was still in its low-connectivity regime. The moment the System resumed chaotic war dynamics in 1763 when the intense rivalry between Britain and France was resolved, the second relatively stable period swiftly – in 1774 – reached the tipping point. The high-connectivity regime, in combination with chaotic non-systemic war dynamics – that are more restrained – then allowed for the 'charging' of the System, for the buildup of a free energy release deficit, and the crystallization of vulnerable issue clusters with fractal structures, that would eventually (1792) percolate the System, and cause it to become critical.

097 The severities of successive systemic wars is a power-law function of population size of the System with scaling exponents b » 1,22 (with R2 = 0,94).

KEY WORDS *Singularity dynamic, Severity, Systemic war, Scaling, Population size.*

During the unfolding of the first finite-time singularity dynamic the System produced four systemic wars. In below table I show the severities of successive systemic wars (38), including the estimated population size of Europe at the start of these wars.

This analysis shows that the severities of systemic wars is a power-law function of population size of the System (Europe) with a scaling exponent of $\beta \approx 1{,}22$ (and $R2 = 0{,}94$). With a scaling exponent of $\beta \approx 1{,}22$ there is a superlinear relationship, this relationship explains why upgraded orders had to be implemented at an accelerating rate in the System (through systemic wars), to avoid too high levels of disorder (and stagnation) in the System (the correlation length of the severities and life spans of successive systemic wars is –0,99).

It is interesting to note that Bettencourt et al. observe that many 'urban indicators' related to social currencies as information, innovation and wealth, scale superlinear with city size, and that the $\beta \approx 1,1 - 1,3$; whereas severity of systemic wars scales superlinear with the size of the System (11). The fact that the scaling exponent of severity of systemic wars/population size is within this range could point to the intrinsic social nature of systemic war.

Data for Beta-calculations concerning the first finite-time singularity dynamic (1495-1945)			
	Start year systemic war	Est. population size (in millions, Europe)	Severity (in BCD) of Systemic war
1	1618	115	1971000
2	1792	195	2532000
3	1914	450	7734300
4	1939	525	12948300

Table 70 *This table shows the data used for the Beta-calculation discussed in this statement.*

I assume, as is the case for the β's related to city-dynamics, that the exact value of β is determined by characteristics of the network that underlies these dynamics, especially its connectivity. The increasing severity of successive systemic wars were unsustainable in two respects; it implied the deployment of (ultimately) infinite levels of destructive energy that simply could not be produced, and if deployed, would guarantee the total destruction of the System. Meanwhile, the whole objective of systemic wars is to implement upgraded orders that allow for lower energy states of the System, to enable the fulfilment of basic requirements of uneven states in the anarchistic System. The moment in 1939, the anarchistic System reached the critical connectivity threshold, it produced infinite amounts of free energy (tensions), collapsed, and experienced a dual-phase transition.

098 The life spans of relatively stable periods and systemic wars of successive cycles accelerated with the same rate, consistent with the assumption that population growth determined the accelerating pace of life of the System.

KEY WORDS *Cycle, Life span, Acceleration, Synchronization.*

During the 1495-1945 period the anarchistic System produced a finite-time singularity dynamic accompanied by four accelerating cycles. Each cycle typically consists of a relatively stable period, followed by a systemic war (a critical period). During the unfolding of the finite-time singularity dynamic the life span of successive cycles became shorter at an accelerating rate.

Analysis shows that the life span of relatively stable periods and systemic wars of the first three cycles of the actual finite-time singularity dynamic accelerated with about a similar rate.

However, I assume that the life span of the first relatively stable period (1495-1618) is actually estimated too short: I assume that the first relatively stable period – in other words the finite-time singularity – started at an earlier time, as I explain in more detail in part II.

I also I assume, that the life span of the second relatively stable period was extended as a consequence of the abnormal non-systemic war dynamics during the first exceptional period (1657-1763), see also part II.

If the life spans of the first second relatively stable periods are corrected, the life span of relatively stable periods and systemic wars of the first three cycles of the adjusted finite-time singularity dynamic accelerated with exactly the same rate.

I applied an correction of 15 years to the life span of the first relatively stable period of the first cycle (start 1480 instead of 1495, the life span is extended from 153 to 168 years) and a correction to the life span of the second relatively stable period of 13 years (assuming the non-systemic war dynamics were not distorted during the first exceptional period, see also part II).

I assume that the connectivity of the System determines its pace of life; population growth determines the System's acceleration, of relatively stables as well as systemic wars.

The fact that both 'components' (relatively stable periods and systemic wars) of successive cycles accelerated at the same rate is consistent with the assumption that the (growing) connectivity of the System determined its (increasing) pace of life.

Life spans of cycles, relatively stable periods and systemic wars First finite-time singularity dynamic (1495-1945)									
	Cycle			Relatively stable period			Systemic war		
	Start	*End*	*LS*	*Start*	*End*	*LS*	*Start*	*End*	*LS*
1	1495	1648	153	1495	1618	123	1618	1648	30
2	1648	1815	167	1648	1792	144	1792	1815	23
3	1815	1918	103	1815	1914	99	1914	1918	4
4	1918	1945	27	1918	1939	21	1939	1945	6

Table 71 *This table shows the Start- and end-dates, and the duration of the cycles, relatively stable periods, and systemic wars of the first finite-time singularity dynamic (1495-1945).*

Corrected ('theoretical') Life spans of cycles, relatively stable periods and systemic wars First finite-time singularity dynamic			
	Cycle	Relatively stable period	Systemic war
1	168	138	30
2	154	130	23
3	103	99	4
4	22,5	20	2,5

Table 72 *This table shows the 'corrected' life spans of the cycles, relatively stable periods and systemic wars of the first finite-time singularity dynamic.*

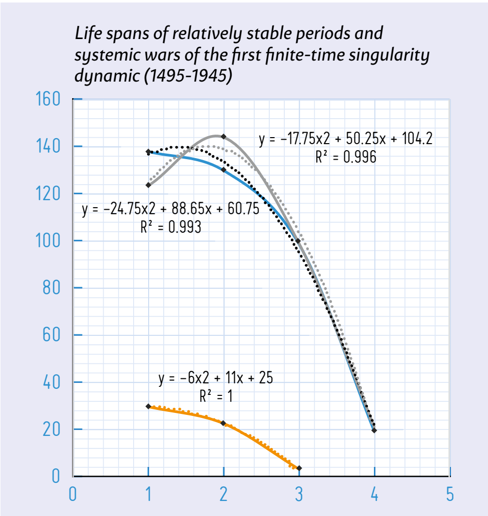


Figure 84
In this figure the life spans are shown of the actual relatively stable periods (international orders) in grey, of the theoretical (corrected) relatively stable periods (international orders) in blue, and of the first three systemic wars of the first finite-time singularity dynamic (actual), in orange; the fourth systemic war is excluded from this analysis because of a significant 'distortion' that can be attributed to the globalization effect. The correlation coefficient of the life spans of the first three relatively stable periods (actual) and of the first three systemic wars (actual) is 0.73, and the correlation coefficient of the first three relatively stable periods (theoretical) and of the first three systemic wars (actual) is 1.00.

I disregarded in these calculations the life span of the fourth cycle: the trend line of the actual and theoretical life spans of the first three systemic wars suggest that the life-span of the fourth systemic war should be –27 years, if consistency is assumed. This does not make much sense.

I assume that this effect is indicative for the obsolescence of the anarchistic System, and its (unavoidable) collapse in 1939.

099 Tensions that 'accompany' interactions in anarchistic systems, can be understood as 'transaction costs' that are and must be (eventually) released.

KEY WORDS *Interactions, Connectivity, Anarchy, Transaction costs.*

This study shows, that over time – during the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) – states and their populations became increasingly dependent on each other for the fulfillment of their basic requirements, and their survival. However, as a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems, at the same time the System produced accelerating amounts of free energy (tensions).

(Increasing) economies of scale and scope that are developed and leveraged through interactions between states (populations), are counterbalanced by increasing levels of tensions (free energy) that accompany these interactions. Each interaction (connection) in anarchistic systems comes with a transaction cost in the form of tensions. Transaction costs (in this context) are costs for interactions between states (populations) in the anarchistic System: costs for participating in an anarchistic system.

Transaction costs are 'social' in nature, and also apply to states and populations that are not directly involved in interactions.

(Accumulated) transaction costs are (eventually) released through wars.

100 **Connectivity is the selection force of the anarchistic System**.

KEY WORDS *Anarchistic System, Units, States, Connectivity, War, Selection, Survival of the fittest.*

In 1495 the System started as a collection of divers units, with different organizational structures, capabilities and attributes. As a consequence of connectivity growth – the control parameter (driver) of the System – the anarchistic System produced free energy (tensions), that was periodically put to work to comply with the second law of thermodynamics, and units had to 'adapt' to, to ensure their survival.

Inadequate responses to these conditions (the production and use of tensions by wars) negatively affected the unit's ability to fulfill its basic requirements, including its security, and its survival changes.

Connectivity worked – and still works – as a selection force. The fittest organizational structure, the structure best adapted to increasingly higher tension levels, and increasingly intense systemic wars, survived. This structure happened to be the state, because of the attributes it developed over time, including: central control over a specific area and its population(s), in which the application of force was monopolized, and its ability to mobilize its society for war and deploy increasing amounts of destructive energy.

5 CRITICALITY, SELF-ORGANIZED CRITICALITY AND 'AT THE EDGE OF CHAOS'

101 Criticality is a prerequisite for the implementation of upgraded orders in the System.

KEY WORDS *Upgraded orders, Criticality, Systemic war, second law of thermodynamics, Lower energy state.*

A critical system – a critical point – typically has a correlation length that spans the system (the correlation length is one); a correlation length of one enables system-wide communication, coordination and planning; a critical system is highly susceptible for perturbations.

Only if the anarchistic System is critical – as happened four times during the unfolding of the finite-time singularity dynamic – the System has the appropriate properties that allow for the collective design and implementation of upgraded orders.

Systemic wars are manifestations of criticality of the anarchistic System. The finite-time singularity dynamic (1495-1945) was accompanied by four accelerating cycles. Each cycle typically consisted of a relatively stable period, followed by a systemic war (critical condition). During relatively stable periods the System produces non-systemic - 'localized '- wars. The sizes of these wars (as well as their frequencies) are determined by the connectivity of the network of issues and states; the connectivity of this network continuously increases. At a certain point during the life cycle of relatively stable periods (international orders), the increasing connectivity of states in the network of issues and states, cause these states to become more stable, and the sizes of non-systemic wars as a consequence decrease.

However, the production of free energy (tensions) still continuous at an accelerating rate, and instead of being released, the free energy (tensions) that is produced during high-connectivity regimes, crystallizes in underlying vulnerable issue clusters; clusters of issues that are one step from being activated to war.

During high-connectivity regimes – when these dynamics typically develop – the System builds up free energy release deficits, that are eventually released when the underlying vulnerable issue clusters connect and percolate the System; at that point, the System becomes critical and produces a systemic war.

The function of systemic wars is to re-establish order – to implement upgraded orders – that allow for a lower energy state of the System, as demanded by the second law of thermodynamics. As explained, the typical properties of a critical condition (during systemic wars), ensure that upgraded orders can be implemented at a system-wide scale.

102 At least two degrees of freedom – chaotic non-systemic war dynamics – are required for the System to achieve a critical condition.

KEY WORDS *Chaotic non-systemic war dynamics, Degrees of freedom, Criticality, High-connectivity regime, Free energy release deficit, Energy storage, Crystallization, Charging, second law of thermodynamics.*

The dynamics and mechanisms discussed in this study also suggest that, for the System to become critical, chaotic conditions with more than two degrees of freedom are required. The moment during the second relatively stable period (the second international order, 1648-1792) the System resumed chaotic non-systemic war dynamics (1763), the connectivity of the issue network could increase again, and the second relatively stable period could reach its tipping point; this happened in 1774. From 1774 onwards – until the System became critical and produced the second systemic war (the French Revolutionary and Napoleonic Wars, 1792-1815) – the System was in a high-connectivity regime, when typically, states become more stable as a consequence of the increasing connectivity of the network of issues and states in the System they are an integral part of. During high-connectivity regimes free energy (tensions) is increasingly inhibited from being released through systemic wars; this is the connectivity/local stability-effect.

Instead of being released, during high connectivity regimes free energy (tensions) crystallize in underlying vulnerable issue clusters with fractal structures, that eventually percolate the System and cause the System to become critical and produce a systemic war. During high-connectivity regimes the System becomes charged – primed – through the free energy release deficit it builds up; the underlying vulnerable issues clusters constitute this deficit through the increasing levels of free energy it contains. The energy will – as explained – eventually be released at a system-wide scale (enabled by the critical condition of the System), and be put to work (through systemic war) to design and implement an upgraded order that enables a lower energy state of the System, consistent with the demands of the second law of thermodynamics.

This effect – the charging of the System – could not be accomplished when interactions between states were unrestrained ($n = 2$); the System could not reach the high-connectivity regime.

103 The ability of the System to become critical determines its evolvability and sustained survival.

KEY WORDS *Criticality, Evolvability, Basic requirements.*

Criticality fulfills a vital function for the System; only in case of (periodic) criticality can the System upgrade its orders, consistent with the demands of the second law of thermodynamics. The ability of the System to become critical determines its evolvability. Evolvability refers to the System's capacity for adaptive evolution: its ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars. Evolvability determines the sustained ability of the System, given the changing connectivity conditions of the System and its consequences, to maintain its performance. The performance of the System determines the System's ability to ensure the balanced fulfillment of basic requirements by uneven states in the anarchistic System. Criticality is about evolvability, and evolvability is about sustained survival of states.

104 The System does not qualify as a SOC-system.

KEY WORDS *SOC, Critical point, attractor, Steady state, second law of thermodynamics.*

This research shows that, at first sight, the System comes close to qualifying as an SOC system. However, closer inspection reveals that the System lacks the most fundamental component for qualification. Although the System reached a critical point four times, a critical point is not the attractor of the System. The System does not reach a stationary state at the critical point.

Criticality of the System implies systemic war, and vice versa. As I explained, such a critical condition is practically not achievable or desirable; it requires the constant input of destructive energy, unavoidably leading to destruction of the System. Systemic wars (criticality) are 'used' by the System to create new order, by putting free energy to work consistent with the requirements of the second law of thermodynamics.

Systemic wars constitute a paradox: they create order, through destruction. During systemic wars issues and tensions are destroyed to enable the design and implementation of upgraded orders that allow for the balanced fulfillment of basic requirements by uneven states in an anarchistic System.

The war dynamics of the System and their properties suggest that the System belongs to the category of 'slowly driven interaction-dominated threshold systems' with the caveat that the System is increasingly 'faster driven' as a consequence of the increased pace of life of the System; a property that can be attributed to the increasing connectivity of the System. In the case of the System, relatively calm and stable periods are punctuated by systemic wars. During these relatively stable periods in between successive systemic wars, only gradual development of the System takes place. During systemic wars, however, the System undergoes significant change: Through systemic wars (consistent with the second law of thermodynamics) upgraded (international) orders are implemented that allow for a new period of relative stability and growth. The driving force of the System is its connectivity,

Various factors belonging to the deterministic and the contingent domain contribute to a threshold effect: forces that try to maintain the status quo, the inertia of the system caused by interests that try to prevent war from breaking out, a network-effect that creates local stability, the requirement to fulfill basic requirements other than security, rules of the System ('international law') that try to avoid conflict between states, etc. Typically, for slowly driven interaction-dominated threshold systems, the release events occur on a significantly faster timescale than the slow-driving build up that issues and tensions cause. This is also the case for the System. Systemic wars constitute the release events of the System, and their life span is significantly shorter than that of preceding relatively stable periods.

105 Although the System self-organizes to criticality, criticality is not the attractor of the System; the System does not qualify as a SOC-system.

KEY WORDS *Criticality, Attractor, Intrinsic incompatibility, Free energy, Acceleration, SOC.*

A multitude of interactions between states in the System produced a self-organized (emergent) finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945). The singularity dynamic determined and shaped the dynamics and development of the System towards the dedicated non-anarchistic hierarchies that were eventually implemented in the core of the System (Europe) through a phase transition (the fourth systemic war, the Second World War, 1939-1945); the phase transition was 'triggered' - had become necessary - when the System in 1939 reached the critical connectivity threshold.

'Self-organized' refers to the property of these dynamics that permits structures and accompanying dynamics to emerge spontaneously without any human control or design. During the 1495-1945 period, the singularity dynamic produced four accelerating cycles; each cycle consisting of a relatively stable period followed by a critical point (systemic war); the System – in other words – became four times critical during the 1495-1945 period.

During criticality the System put free energy to use through systemic wars, that had been building up during preceding relatively stable periods; this energy was put to work to implement upgraded orders that allowed for lower free energy state of the System; a lower energy state of the System is equivalent with a relatively stable period that allows states and the System to further grow and develop.

The intrinsic incompatibility between increasing connectivity and security in anarchistic systems produced the energy that powered the singularity dynamic; connectivity growth was the driver of the singularity dynamic.

Self-organized critical (SOC) systems are systems that self-organize towards criticality, and then find a steady state at the critical point. Certain systems are self-organized critical systems because at the critical point they optimize their performance by making use of critical phenomena like infinite susceptibility and correlation length spanning the system, which enables system-wide communication, coordination, and planning. Certain processes in the brain, for example, are probably SOC (10).

Although the System has certain similarities with SOC-systems, the System does not reach a steady state at the critical point, in a state of systemic war; the critical point of the System is, in other words, not its attractor. Criticality is used by the System to re-establish order, using certain critical phenomena. A correlation length of one at criticality is one such useful property; it enables system-wide communication, coordination, and planning, necessary for the design and implementation of a new updated system-wide order.

The nature of criticality – of systemic wars – in the System manifested is necessarily destructive. The implementation of upgraded orders requires the destruction of the preceding increasingly dysfunctional order, that was increasingly hindered by unresolved issues and tensions (that had accumulated in underlying vulnerable issue clusters and a free energy release deficit). The design and implementation of upgraded orders also involves the deployment of destructive energy to ensure that states in the System submit to the demands of more powerful states.

During criticality, free energy (tensions) is put to work, through the deployment of destructive energy. The deployment of this destructive energy and the transformation of tensions into destructive energy disrupt the ability of states to fulfill other basic requirements and pose a risk to their internal balance. Because of the destructive nature of systemic wars, their disruptive effects, and the huge amount of resources these wars require, criticality can only be endured for a short duration.

Contrary to other SOC-systems, criticality of the System is not a functional steady state condition. During criticality the System must re-order, because it cannot ensure the balanced fulfillment of basic requirements of uneven states in the System, and states themselves are forced to redirect resources and priorities to the production, mobilization, and deployment of destructive energy, thus risking internal imbalance.

The System and states need criticality – and relatively stable periods – to ensure evolvability and continued performance of the anarchistic System.

106 At a critical point the susceptibility of the System is infinite.

KEY WORDS *Critical point, Susceptibility, Correlation length of one, Properties.*

Susceptibility of systems to perturbations at criticality, like events, and incidents in case of the System, is 'infinite'; this phenomenon is closely related to the correlation length (a correlation length of one) that spans the System at that point. A correlation length of one enables system-wide communication, coordination, and planning.

A perturbation, for example an incident in the System at a particular 'location' in the System, is immediately communicated with the rest of the System. When the correlation length spans the System, properties of the

System render 'local' meaningless; the System responds as a system, and cause and effect become unconnected and often disproportional.

Such system properties, including infinite susceptibility and the ability for system-wide communication, coordination, and planning at criticality, also explain the response of the System to the assassination of Archduke Franz Ferdinand in June 1914 in Sarajevo.

The underlying vulnerable issue cluster that had been building up preceding this incident, had by then percolated the System; causing the System to become critical and infinitely susceptible to incidents. At that point a response could not be restrained because 'local' had lost its meaning; the System responded to this relatively minor incident as a fully connected system with a systemic war. From the perspective of the second law of thermodynamics, this response was predictable.

Historians and social scientists (18) who are not aware of the deterministic characteristics of the System have tried to comprehend and make sense out of the apparently disproportionate reaction of the First World War: Historians have tried to connect effects and responses of states, that cannot be connected.

107 The level of susceptibility of the System developed very regularly and predictably during the unfolding of the finite -time singularity dynamic accompanied by four accelerating cycles (1495-1945). Only during the exceptional period (1657-1763) was there a distortion.

KEY WORDS *Level of susceptibility, Life cycle.*

Susceptibility of the System during successive cycles of the singularity dynamic – except for a distortion caused by the first exceptional period (1657-1763) during the life cycle of the second relatively stable period (1648-1792) – developed as follows; three phases during relatively stable periods (international orders) can be distinguished:

1 ***Increasing susceptibility***
During low-connectivity regimes of relatively stable periods following systemic wars, the susceptibility of the System for perturbations (incidents and events) increased until the tipping point of the relatively period was reached.

2 ***Decreasing susceptibility***
During high-connectivity regimes of relatively stable periods, susceptibility of the System for perturbations decreased to almost zero, shortly before the underlying vulnerable issue cluster percolated the System and produced a critical condition (systemic war).

3 ***Infinite susceptibility***
Susceptibility of the System became infinite at criticality, that is, during

systemic wars. In the case of criticality, responses of the System became system-wide, and issues and ('local') wars very fast became connected and 'transformed' into systemic cooperative phenomena.

During the first exceptional period (1657-1763) this sequence was distorted. During the first exceptional period the number of degrees of freedom (n) of the System was temporarily reduced to two ($n = 2$), resulting in periodic instead of chaotic non-systemic war dynamics; as a consequence, the non-systemic war dynamics became temporarily hyper-excited.

108 The 'At the edge of chaos' concept proposed by Kauffman, does not apply to the System.

KEY WORDS *At the edge of chaos, Framework, SOC.*

Kauffman et al. suggest that certain systems optimize their evolvability at the edge of chaos. 'At the edge of chaos' refers to a critical condition between a condition of order and complete chaos (36). The mechanisms and logic Kauffman proposes in his study *'The Origins of Order, Self-organization and Selection in Evolution'* are to a high degree similar to the concept of self-organized criticality (SOC), as proposed by Bak et al. (3), (4), (5).

In case SOC applies to a system, the system 'self-organizes' towards a critical condition, and eventually 'finds' a steady state at the critical point. A critical point typically is the attractor of SOC-systems. SOC-theorists argue that certain functions of SOC-systems – including their evolvability – are optimized at critical points, because system-wide communication, coordination and planning are then enabled.

The development of the finite-time singularity dynamic and the System show that SOC and the concept of 'at the edge of chaos' do not apply to the System, and that the System instead achieved optimal performance and evolvability through self-organized oscillations between subcriticality (relatively stable periods that allowed for the fulfillment of basic requirements by states and their populations, and charging of the System) and criticality, when the System put free energy to work that had accumulated in the System, to implement upgraded orders that allowed for a lower energy state of the System. The nature of criticality of the System, implying systemic war and massive destruction, also does not allow this condition to be the attractor – steady state – of the System.

109 Criticality ensures efficient destruction of issues and tensions and a fast and efficient design and implementation process of upgraded orders.

KEY WORDS *Criticality, Upgraded orders, Destruction, Design, Implementation.*

During the unfolding of the finite-time singularity accompanied by four accelerating cycles (1495-1945), the anarchistic System experienced criticality at an accelerating rate four times. In the contingent domain, criticality produced systemic wars. During systemic wars, free energy, which manifests itself as tensions and destructive energy in the contingent domain, was put to work to establish upgraded orders that allowed for a lower energy state of the System, consistent with the second law of thermodynamics. Periodic criticality was (and still is) a necessary precondition for timely adaptation of the System to changed circumstances.

Criticality is accompanied by critical phenomena, including a correlation length of the System at criticality of one, allowing for system-wide communication, coordination, and planning. Criticality is a prerequisite for the ability of the System to collectively design and implement viable worldwide orders.

To accomplish the implementation of a viable upgraded worldwide order, a systemic war must accomplish the following objectives:

1) **Destruction** of issues and tensions that increasingly hinder the fulfillment of basic requirements of states during relatively stable periods. I also refer to this as ‘unfreezing’.

2) **Design** of upgraded orders that represent the actual balance of power and interests of states that make up the System (‘change’).

3) **Implementation** of upgraded orders, which I call ‘freezing’.

I consider the remarkably regular and consistent development and unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles proof of the optimality of its dynamics and of its components, including systemic wars. As explained in this study, the start time, duration, and intensity of successive systemic wars (for example) developed very regularly and followed precise mathematical equations.

The abnormal non-systemic war dynamics during the exceptional period (1657-1763) also provide insights into the function and workings of the singularity dynamic, and confirm the singularity’s optimality under normal default conditions.

110 The System does not optimize its functions ‘at the edge of chaos’ as observed in certain categories of systems by Bak et al. and Kauffman, but by oscillating between subcriticality and criticality through a finite-time singularity accompanied by four accelerating oscillations.

KEY WORDS *Edge of chaos, Optimization, SOC.*

The frameworks that Kauffman (‘at the edge of chaos’) and Bak (self-organized criticality, SOC) propose are similar in principle; both frameworks assume that certain systems find a steady state at criticality because certain functions of these systems are optimized at critical points. Examples are energy redistribution in avalanche dynamics of sand piles (3), (4), (5) information processing in case of the brain (10), and evolvability in parallel processing systems (36).

The System, however, did not – and cannot – find a steady state 'at the edge of chaos' and does not qualify as a SOC-system. Unlike certain other systems, the System cannot stabilize at criticality because of the function and nature of criticality in the System. A steady state of the System at a critical point, apart from the fact that it does not make sense from a functional perspective, would imply the (self-)destruction of states and their populations, that make up the System.

The critical point of the System is also not situated between order and chaos, as Kauffman suggests. Critical points of the System – that is systemic wars – are 'situated' between two successive relatively stable periods that (normally) produce chaotic non-systemic war dynamics.

It would be confusing to use Kauffman's framework as a reference. Relatively stable periods in the System qualify as ordered states, however, during these ordered states the System typically produces chaotic non-systemic war dynamics (except for the exceptional period, 1657-1763). Contrary to the systems Kauffman envisions, chaotic non-systemic war dynamics in the System during relatively stable (ordered) periods were highly functional and essential for the System to reach a critical condition, that allowed for further 'evolution'. Furthermore, this study shows that without chaotic non-systemic war dynamics, the System cannot produce percolating vulnerable issue clusters with fractal structures, and cannot become critical and implement upgraded orders.

111 The long-term war dynamics of the System (1495–1945) display 'punctuated equilibrium' dynamics.

KEY WORDS *Anarchistic System, Finite-time singularity dynamic, Cycles, Relatively stable periods, Systemic war, Innovations.*

During the life span of the System (1495-1945) relatively long stable periods were periodically (four times, at an accelerating rate) punctuated by relatively short systemic wars (critical periods). During relatively stable periods the System produced non-systemic wars that did not impact on the organization (the international order) of the System; fundamental change of the System (its order) was accomplished by relatively short systemic events.

Below table shows what organizational innovations (i.e., changes) were introduced through the four systemic wars that can be distinguished.

Innovation through systemic wars 1495-1945			
	Systemic War	Period	'Innovation'
1	Thirty Years' War	1618-1648	Sovereignty principle, legitimation of states: Rules
2	French Revolutionary and Napoleonic Wars	1792-1815	Concert of Europe: Coordination mechanism
3	The First World War	1914-1918	League of Nations: Coordination mechanism, rules that restrict behavior
4	The Second World War	1939-1945	Implementation of two dedicated non-anarchistic hierarchies in Europe, and a first global order

Table 73 *This table shows the 'innovations' that were implemented through successive systemic wars, during the unfolding of the first finite-time singularity dynamic, accompanied by four accelerating cycles (1495-1945).*

112 This study shows, that the anarchistic System comes close to qualifying as an SOC-system. However, closer inspection reveals that the System lacks the most fundamental component for qualification: Although the System reached a critical point four times, a critical point is not the attractor of the anarchistic System; the System does not reach a stationary state at the critical point.

KEY WORDS *SOC, Critical point, Attractor, Periodic upgrades, Population growth, Powering of the Singularity dynamic.*

However, criticality of the anarchistic System is periodically unavoidable – and necessary – for the anarchistic System to upgrade its order, to allow for a lower energy state of the System, and a new relative stability period.

Periodic criticality ensures the balanced fulfillment of basic requirements of uneven states in the anarchistic System, and further population growth. Population growth is required for the anarchistic System to produce enough free energy (tensions) to ensure the further development and unfolding of the Singularity dynamic.

6 ROBUSTNESS, FRAGILITY AND (STRUCTURAL) STABILITY

113 During the unfolding of the first finite-time singularity dynamic (1495-1945), the anarchistic System became increasingly unstable.

KEY WORDS *Singularity dynamic, Oscillations, Cycles, Acceleration, Unstable, Damping oscillation.*

The unfolding of the first finite-time singularity (1495-1945) shows that the anarchistic System became increasingly unstable over time; oscillations were produced at an accelerating rate and with an accelerating strength. The strength (amplitude) of oscillations (cycles) of the singularity dynamic concern the severities of systemic wars. Severity is defined as the number of battle-connected deaths of military personnel of Great Powers that are involved (38). I consider the severity of wars (in terms of BCD) a measure for the amount of destructive energy (weapons, violence) that is deployed.

As Sterman explains, it is possible to make a distinction between locally stable and locally unstable equilibriums (69).

1 *Locally stable equilibriums*

In case of a locally stable equilibrium, "perturbations will cause the system to oscillate, but it will eventually return to the same equilibrium". Such oscillations qualify as damping oscillations; in case of damping oscillations, oscillations die out over time. The equilibrium of a damped oscillator is said to be locally stable. The war dynamics during the first international order (1495-1618) - the first relatively stable period of the first cycle of the singularity dynamic - behave as a damping oscillator, see also part I.

2 *Locally unstable equilibriums*

"While many oscillatory systems are damped, the equilibriums of other systems are locally unstable, meaning that small disturbances tend to move the system farther away from the equilibrium point" (69). The System during the 1495-1945 period obviously does not qualify as a *damped* oscillator: Because the equilibrium of the System is unstable, the oscillations (cycles) of the anarchistic System accelerated during the unfolding of the finite-time singularity dynamic: the frequency as well as the amplitudes of successive oscillations accelerated, until the System's collapse in 1939.

However, "while an equilibrium may be locally unstable, any real system must be globally stable." "Global stability means the trajectories of the system do not diverge to infinity: the trajectories are bounded because the positive feedbacks leading to the accelerating flight from the balance point must ultimately be limited by various negative loops", as is ultimately also the case for the System. Finite-size effects ultimately limited the 'escalating' dynamics of the System.

114 Increasing robustness and increasing fragility of the anarchistic System are two sides of the same coin.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Intrinsic incompatibility, Connectivity growth, Critical connectivity threshold, Collapse, Robustness, Non-systemic wars, Fragility, Systemic wars, Dual-phase transition.*

Robustness and fragility are closely related, interacting properties of the anarchistic System; in fact, two sides of the same coin: increasing robustness goes hand in hand with increasing fragility.

During the period 1495–1945, a finite-time singularity accompanied by four accelerating cycles determined the war dynamics of the anarchistic System, and ultimately produced a dual-phase transition in 1939, when the anarchistic System reached the critical connectivity threshold and collapsed as a consequence. The dual-phase transition resulted in the simultaneous implementation of two dedicated non-anarchistic hierarchies in Europe (the core of the System), and the first global order at a global scale of the System.

The four accelerating cycles that accompanied the finite-time singularity dynamic exhibit remarkable regularities and consistencies in their dynamics and development.

Typically, a cycle consists of a relatively stable period (international order), followed by a systemic war. During relatively stable periods of cycles the anarchistic System produces non-systemic wars.

When cycles are used as the unit of analysis, it can be observed that the absolute number of non-systemic wars during successive relatively stable periods (eight expansion wars excluded), the non-systemic war frequency of successive cycles, and the status dynamics of the System all decreased linearly over time, until a value of (nearly) zero was reached during fourth relatively stable period (1918-1939) of the singularity dynamic (1495-1945).

I define 'robustness' of the System as its ability to 'absorb' perturbations (incidents and events) without producing non-systemic wars. I consider the absolute number of non-systemic wars and the non-systemic war frequency during cycles measures for the Systems robustness. This implies that during the period 1495–1945 (the life span of the finite time singularity dynamic), the robustness of the System increased linearly and became absolute when the connectivity of the System reached a critical threshold in 1939. The increasing robustness of the System can be attributed to its increasing connectivity: increased connectivity elevates the local stability of the System. The fact that the robustness became absolute in 1939 meant that the System had become insensitive to perturbations, and triggers (incidents) immediately encountered stable states in the network, prohibiting further propagation. At that point, the anarchistic System had become 'disabled' to release free energy through non-systemic wars, while simultaneously producing infinite levels of free energy.

This condition of the anarchistic System – absolute robustness, in combination with the production of infinite amounts of free energy (tensions) –

caused a fundamental problem: Free energy could now only be released and put to work through systemic war; the increased robustness of the System (a decreases in the number of non-systemic wars) came – so to say – at a price.

Fragility concerns another – closely related – property of the anarchistic System. Fragility concerns the ability of the System to maintain itself within a certain stability domain. International orders are, in systems terminology, stability domains. The life span of successive international orders (relatively stable periods) is a measure for the fragility of the System. The singularity dynamic produced free energy, and as a consequence cycles, at an accelerating frequency. This frequency of cycles became 'infinite' when in 1939 the finite-time singularity dynamic reached the critical connectivity threshold (and the singularity occurred). This also implies that the fragility of the System at that point reached infinity, resulting in its collapse.

Development of the actual robustness and fragility of successive international orders (1495-1945)

Rel. Stable period / int. Order	Period	Life span	Number of non-systemic wars	War Frequency
1	1495-1618	123	45	0,37
2	1648-1792	144	34	0,24
3	1815-1914	99	16	0,16
4	1918-1939	21	2	0,10

Table 74 *This table shows the indicators for the actual robustness (number of non-systemic wars and war frequency of international orders, eight expansions wars excluded) and for the fragility of successive orders (life span) of the first finite time singularity dynamic accompanied by four accelerating cycles (1495-1945).*

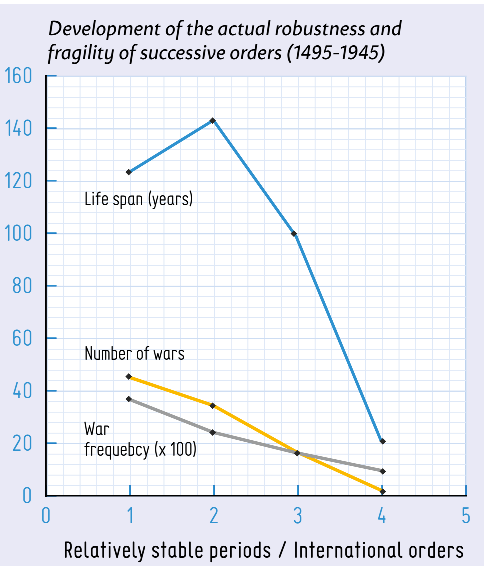
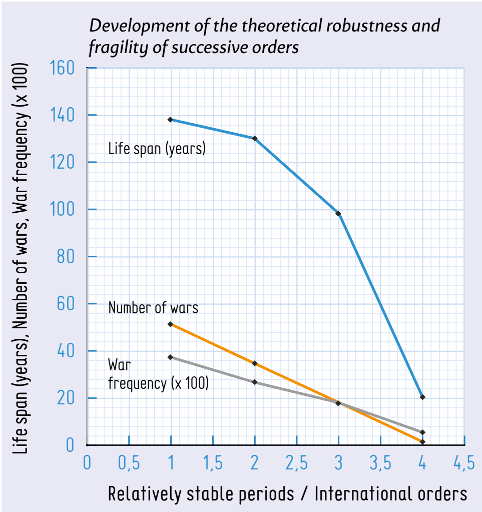


Figure 85
In this figure the development of the life spans of successive orders (blue) is shown (this is a measure for the fragility of the System), and of the absolute number of non-systemic wars (orange, eight expansion wars excluded) and of the war-frequency (grey) of successive international orders, which are measures for the robustness of the System. This figure concerns the actual finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945).

Development of the theoretical robustness and fragility of successive international orders (1495-1945)				
Rel. Stable period / int. Order	Period	Life span	Number of non-systemic wars	War Frequency
1	NA	138	51	0,37
2	NA	130	34	0,26
3	NA	99	17	0,17
4	NA	20	1	0,05

Table 75 *This table shows the indicators for the theoretical robustness (number of non-systemic wars (orange) and war frequency (grey, x 100) of international orders; eight expansion wars excluded) and for the fragility (blue) of successive orders (life span) of the first finite time singularity dynamic accompanied by four accelerating cycles. NA means 'not applicable'.*

Figure 86
In this figure the development of the life spans of successive orders (blue) is shown; this is a measure for the fragility of the System, and of the absolute number of non-systemic wars (orange, eight expansion wars excluded) and of the war-frequency (x 100, grey) of successive international orders; measures for the robustness of the System. This figure concerns the theoretical finite-time singularity dynamic accompanied by four accelerating cycles.



Connectivity growth caused the accelerating frequency of the cycles composing the singularity dynamic. The increasing robustness and fragility of the System are also both caused by greater connectivity of the System. Robustness is about non-systemic wars, fragility is about systemic wars. As I already explained, while the System became more robust, the System at the same time also produced (because of a simultaneous intensification of the incompatibility between increasing connectivity and security) more issues and tensions (free energy), the System had to deal with. The increasing and ultimately 'infinite' robustness of the System impacted on the energy transfers of the System.

According to the principle that free energy will be put to work, the increasing amounts of free energy (tensions and destructive energy) the System produced – but that were increasingly 'suppressed' by the increasing robustness of the System – had to be released through systemic wars instead. This effect, a necessary redistribution of (increasing levels of) energy to systemic releases (systemic wars), pushed the free energy that was released during systemic wars higher while simultaneously contributing to the acceleration of the frequency of these systemic wars. Exactly at the critical connectivity threshold, the dynamics and certain properties of the System became irreconcilable. While the robustness of the System was absolute at that point, preventing the System from producing non-systemic wars, the fragility of the System reached infinity at the same time, implying the emergence of systemic wars at an infinite rate. Collapse of the anarchistic System and a phase transition became unavoidable as a consequence. The System obeyed the principle of least free energy (deterministic domain), and produced a 'new' viable non-anarchistic order that was, contrary to its anarchistic predecessor, compatible with the level of connectivity that the System had reached.

115 Robustness, fragility and structural stability are related properties of the System.

KEY WORDS *Structural stability, Robustness, Fragility, Permanence of structures.*

Besides the properties robustness and fragility of the System, it is possible to distinguish the structural stability of the System. Structural stability refers to the permanence of structures in the System. I define structural stability as an absence of fluctuations in the status hierarchy and in the physical distribution of units in the System.

Structural stability, as well as the robustness and fragility of the System, are determined by the System's connectivity. Increasing connectivity results in increasing structural stability and increasing robustness, but also in increasing fragility. Robustness and fragility are two sides of the same coin, and in some respects each other's mirror image. Robustness and structural stability are also closely related properties. Increasing connectivity results in increasing structural stability, in two respects: (1) increasing the ability of the System to absorb perturbations and prevent energy releases from being triggered and cascaded (robustness), and (2) increasing the ability of the (international) order to maintain its organizational and physical structure.

116 The increasing permanence of the Great Power status hierarchy and of the fractal size distribution of states in the System are indicative for the System's structural stability.

KEY WORDS *Permanence, Great Power status hierarchy, Fractal structures, Size-distribution of states, Structural stability, mechanisms.*

Two indicators point to increasing stability of successive orders of the System: the permanence of the Great Power status hierarchy of the System, and the permanence and size distribution of states in the System.

The number of Great Power status changes is indicative of the permanence, or organizational stability, of the Great Power status hierarchy of the System. During the unfolding of the singularity dynamic (1495-1945), the number of Great Power status changes of European states decreased linearly, and stopped altogether during the fourth international order (1918-1939). The organizational order became permanent and stable.

At the same time as Great Power status dynamics decreased, changes in the size distribution of states in the core of the System, Europe, also came to a halt. During the fourth international order (1918-1939), the size distribution of states became permanent and stable, and can be best described by a power-law, pointing to optimized fractal structures of the System. Through these fractal structures, free energy production (the production of tensions) was minimized, and the distribution of destructive energy during systemic wars was optimized. Both dynamics are closely related and coevolved.

Indicators and measures of structural stability of the anarchistic System

Order	Indicator	Measure	Mechanism
Organizational	Permanence of the Great Power status hierarchy	Great Power status dynamics	Coevolution of states and successive international orders, path dependence and lock-in, the 'powerful-become-more-powerful- effect'
Physical	Permanence and size distribution of states	Border changes, and power-law fit	The second law of thermodynamics

Table 76 *This table defines indicators and measures of structural stability of the anarchistic System.*

117 During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the Great Power status dynamics decreased very regularly (linearly), indicative for the increasing structural stability of the anarchistic System.

KEY WORDS *Great Power status dynamics, Structural Stability.*

When the cycles of the finite-time singularity dynamic (1495-1945) are used as 'units' of analysis, analysis shows that the Great Power status dynamics of the System decreased linearly at system level, and about linear in the core of the System (Europe).

Membership of the Great Power System 1495-1975 Based on data Levy (38)		
State	Start	End
France	1495	-
England/Great Britain	1495	-
Austrian Hapsburg/Austria/Austria-Hungary	1495	1519
Austrian Hapsburg/Austria/Austria-Hungary	1556	1918
Spain	1495	1519
Spain	1556	1808
Ottoman Empire	1495	1699
United Hapsburg	1519	1556
The Netherlands	1609	1713
Sweden	1617	1721
Russia/Soviet Union	1721	-
Prussia/Germany/West Germany	1740	-
Italy	1861	1943
United States	1898	-
Japan	1905	1945
China	1949	-

Table 77 *Above table shows the membership of Great Powers in the System during the 1495-1945 period, based on data Levy (38).*

In below table I specify the Great Power Status dynamics of the System during each successive cycle of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945). A Great Power status change can be either 'plus' (a state acquires Great Power status), or 'minus'; a Great Power loses its Great Power status. I Make a distinction between Great Power status dynamics in the core of the anarchistic System (Europe) and in the non-core.

Great Power status dynamics during successive cycles of the first finite-time singularity dynamic (1495-1945)				
	Period		Core (Europe)	Non-core
First international order	1495-1618	Plus	5	
		Minus	3	
First systemic war (Thirty Years' War)	1618-1648	Plus		
		Minus		
Second international order	1648-1792	Plus	2	
		Minus	3	
Second systemic war (Fr. Rev. and Nap. Wars)	1792-1815	Plus		
		Minus	1	
Third international order	1815-1914	Plus	1	2
		Minus		
Third systemic war (First World War	1914-1918	Plus		
		Minus	1	
Fourth international order	1918-1939	Plus		
		Minus		
Fourth systemic war Second World War)	1939-1945	Plus		
		Minus	1	1

Table 78 *This table shows the Great Power status dynamics – 'plus' and 'minus' – during successive cycles during of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), for the core (Europe) and the non-core of the System.*

The analysis shows that at system level (core plus non-core) the Great Power status dynamics decreased linearly during the period (1495-1945); in the core of the System (Europe) the decrease is about linear.

Great Power status dynamics during successive cycles of the first finite-time singularity dynamic (1495-1945): consolidated				
Cycle	Period	Core (Europe)	Non-core	System (core plus non-core)
1	1495-1648	8		8
2	1648-1815	6		6
3	1815-1918	2	2	4
4	1918-1945	1	1	2

Table 79 *This table shows the Great Power status dynamics for each successive cycle, for the core (Europe) of the System, and for the System itself (core plus non-core).*

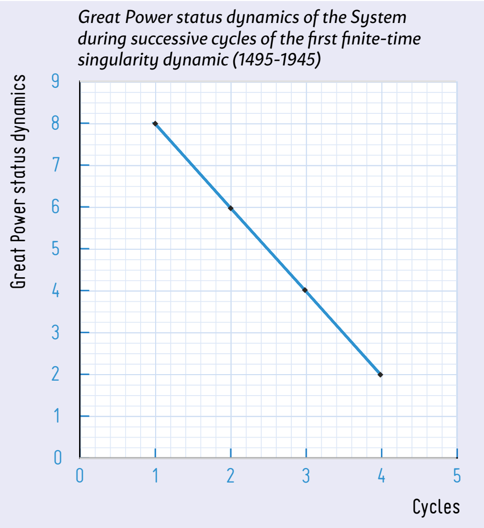


Figure 87
This figure shows in a plot the linear decrease in the Great Power status dynamics of the System, during the four cycles of the finite-time singularity dynamics (1495-1945).

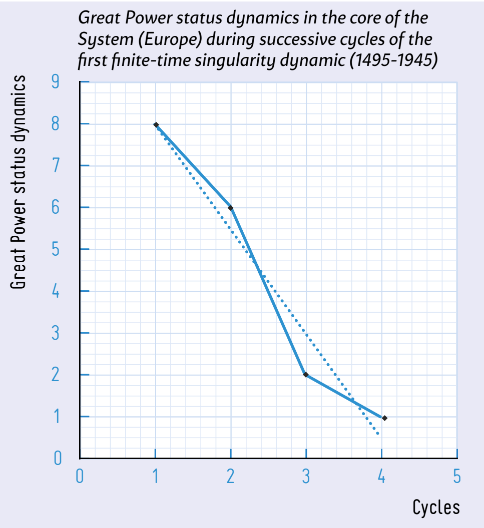


Figure 88
This figure shows in a plot the about linear decrease in the Great Power status dynamics in the core of the of the System (Europe), during the four cycles of the finite-time singularity dynamics (1495-1945).

The decrease in the Great Power status dynamics means that the 'organizational permanence', the Great Power status hierarchy – the structural stability of the (core of the) System – eventual became absolute during the period 1490-1945

118 The robustness, fragility and the structural stability of the anarchistic System increased very regular during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), and became 'absolute' during the lifespan of the fourth international order (fourth relatively stable period, 1918-1939), shortly before the anarchistic System's collapse in 1939.

KEY WORDS *Singularity dynamic, Cycles, Robustness, Fragility, Structural stability, Organizational permanence, Permanence of physical (state) structures, Anarchistic end state, Critical connectivity threshold, Collapse.*

The robustness, fragility and structural stability are related properties of the anarchistic System, and these properties – not coincidentally – are related. Regarding the structural stability of the anarchistic System it is possible to distinguish two related components: an organizational component (the Great Power status hierarchy, and accompanying dynamics) and a physical component (the sizes and distribution of states in the System). I propose that the connectivity of the System (a function of population size/growth) is the 'driver' of these three properties.

As a consequence of the (linearly) increasing robustness of successive cycles of the anarchistic System, the anarchistic System was increasingly impeded in releasing free energy (tensions) through non-systemic wars. The development of the release ratio towards a ratio of one, is indicative for a change in the energy release distribution of the System during the unfolding of the finite-time singularity dynamic (1495-1945), and can be attributed to the increasing robustness of the System. Increasing robustness, implies increasing fragility of the anarchistic System: increasing robustness and fragility are two sides of the same coin.

The increasing structural stability of the anarchistic System, means that the Great Power hierarchy status hierarchy became permanent, not only from an organizational perspective but also in a 'physical' sense. Because of the increasing permanence of these structures, the anarchistic System became increasingly 'settled', during its 'crystallization' towards its end state, and as a consequence increasing levels of destructive energy had to be deployed to make changes in these structures.

In 1939, the System simultaneously reached the critical connectivity threshold and its anarchistic end state: at the same time when the anarchistic System produced infinite amounts of free energy (tensions), this energy could no longer be put to work to (further) upgrade the order of the anarchistic System and ensure compliance with physical laws that apply to the System; as a consequence, the anarchistic System collapsed.

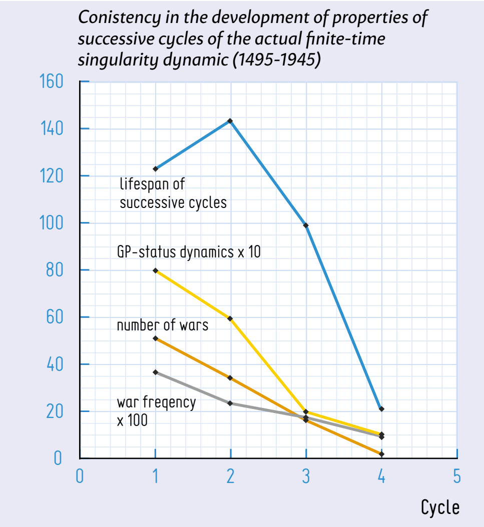


Figure 89
This figure shows the 'converging' and synchronized development of properties of the anarchistic System during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945): The decrease in the lifespan of successive cycles (in blue) is indicative for the increasing fragility of the System; the decrease in the Great Power status dynamics of successive cycles (in yellow, x 10) is indicative for the increasing structural stability of the System; the decrease in the absolute number of non-systemic wars (in orange, eight expansion wars excluded) during successive cycles, and the decrease in the war frequency of successive cycles (in grey, x 100) are indicative for the increasing robustness of the anarchistic System. All properties became 'absolute' during the lifespan of the fourth international order (1918-1939) shortly for the anarchistic System's collapse in 1939.

The direction of the robustness, fragility and structural stability all point to the unavoidable collapse of the anarchistic System, when the anarchistic System reached the end of the lifespan of the fourth international order (the fourth relatively stable period, 1918-1939).

119 The increasing structural stability (permanence) of the Great Power status hierarchy contributed to the intensification of rivalries.

KEY WORDS *Structural stability, permanence, Great Power status hierarchy, Rivalries, Narrowing of competition, Focus war fighting, Coevolution, States, International orders.*

At the same time as the finite-time singularity dynamic produced free energy (tensions) at an accelerating rate, Great Power status dynamics decreased and the Great Power status hierarchy stabilized. Over time, a progressively smaller number of Great Powers was responsible for the tensions the anarchistic System produced, and destructive energy that was (as a consequence) deployed during increasingly intense systemic wars. The intensities between rivalries intensified continuously during the unfolding of the finite-time singularity dynamics (1495-1945).

The competition between Great Powers and states in the System, continuously 'narrowed' on to war-fighting (capabilities) of Great Powers; a dynamic that also was determined and shaped by the finite-time singularity. The coevolution of states and successive international orders through the 'powerful-become-more-powerful' effect, also contributed to the intensification of rivalries between Great Powers.

120 Structural stability, robustness, and fragility are related and coevolving properties of the anarchistic System, determined by the System's connectivity.

KEY WORDS *Structural stability, Robustness, Fragility, Connectivity.*

1 ***Structural stability***

Structural stability refers to the permanence of the structures that developed in the System during the unfolding of the singularity dynamic (1495-1945). Over time, the structural stability of the System increased. I consider two properties of the System – and how they developed over time – important measures for its structural stability: (1) Great Power status dynamics (changes in the Great Power status hierarchy of the anarchistic System), and (2) the size distribution of states in the System, and how this distribution – the sizes and forms of states – changed over time. Both organizational and geopolitical structures are closely related and have become more permanent over time.

Shortly before in 1939 the critical connectivity threshold of the core of the System was reached, the Great Power dynamics of the System had stopped altogether, and the System had reached a permanent fractal size-distribution of states. More structural stability could not be achieved in the anarchistic System. The linear decrease in Great Power status dynamics during successive cycles of the finite-time singularity dynamic shows that the organizational stability of the core of the System increased linearly during the 1495-1945 period.

The level of structural stability of the System – of its successive orders – determined how much destructive energy had to be deployed to accomplish a change in its order. Increasing structural stability required increasing levels of destructive energy to be deployed. Data analysis shows that a linear increase in structural stability and robustness of the System went hand-in-hand with an accelerated requirement for destructive energy to be deployed during successive systemic wars.

2 ***Robustness***

Robustness refers to the ability of the System to absorb perturbations. I consider the number of non-systemic wars the System produced during successive relatively stable periods as a measure of its robustness.

War data (38) shows that robustness of the anarchistic System increased linearly over time. During the unfolding of the singularity dynamic (1495-1945), the number of non-systemic wars decreased linearly during successive relatively stable periods (international orders). When the critical connectivity threshold was reached in 1939, the robustness of the System had become absolute ('infinite'). At that point, the core of the System was unable to produce non-systemic wars. Increasing robustness of successive relatively stable periods is an effect of the increasing connectivity of the System.

The increasing robustness of successive cycles means, that during successive cycles, the System was to an increasing extent obstructed to release free energy (tensions) through non-systemic wars. Furthermore, at the same time as the System became more robust and unable to produce non-systemic wars (non-systemic release events), the System produced accelerating amounts of free energy (tensions) as a consequence of the intrinsic incompatibility between (increasing) connectivity and security of the System.

Instead of being released through non-systemic wars, increasing amounts of free energy (tensions) were – and had to be – released through systemic war.

These effects contributed to the acceleration in the frequency of successive systemic wars, and to an acceleration in the destructive energy that was released during these wars.

3 *Fragility*

Fragility refers to the ability of the System to maintain itself within a certain stability domain. The life span of relatively stable periods is a measure for the fragility of the System. The accelerating frequency of cycles and systemic wars shows that the fragility of the System increased at an accelerated rate and became infinite when in 1939 the core of the System reached the critical connectivity threshold.

Robustness and fragility are two coevolving properties that go hand-in-hand; robustness and fragility are two sides of the same coin. The moment the robustness of the System became absolute, its fragility reached infinity, and the System collapsed as a consequence.

Below table shows the correlation coefficients of properties of successive international orders (relatively stable periods).

Correlation matrix of properties of successive international orders of cycles of the anarchistic System (1495-1945)				
	Lifespan of international orders	Number of wars	War frequency	Structural stability (GP-dynamics)
Lifespan of international orders				
Number of wars	0,82			
War frequency	0,76	0,99		
Structural stability (GP-dynamics)	0,79	0,98	0,96	

Table 80 *This table is shows the correlations between properties of successive cycles (international orders) of the anarchistic System during the 1495-1945 period. The number of wars concerns non-systemic wars during relatively stable periods (international orders), eight expansion wars excluded.*

121 During the unfolding of the finite-time singularity accompanied by four accelerating cycles (1495-1945, the System became more robust and fragile at the same time; robustness and fragility are related properties and both are determined by the connectivity of the System.

KEY WORDS *Singularity dynamic, Robust, Fragile, Connectivity.*

Robustness of the System refers to its ability to absorb perturbing incidents or events without producing energy releases (wars). Robustness is a function of the connectivity of the System; connectivity produces local stabilities. The numbers of non-systemic wars that are produced during successive relatively stable periods of international order are measures of the System's robustness. As the figure below shows, the number of non-systemic wars during successive relatively stable periods decreased linearly, implying a linear increase in the robustness of the anarchistic System.

Increasing robustness of the System came however at a price; increasing robustness of the System negatively affected the ability of the System to release free energy through non-systemic wars, while at the same time, due to the increasing incompatibility of connectivity and security in anarchistic System, the System produced increasing amounts of free energy. As a consequence of these developments the increasing amounts of free energy the anarchistic System produced only were – and could be – released during systemic wars, that were produced at an accelerating rate.

The decreasing life spans of successive relatively stable periods (international) orders is indicative for the increasing fragility of the anarchistic System. When the System in 1939 ultimately became 'infinitely' robust, it also had become infinitely fragile at the same time: robustness and fragility are closely related and coevolving properties. Connectivity of the System is the driver of both properties.

122 During the 1495-1945 period, a – what I call – 'powerful-become-more-powerful effect' contributed to the shaping and increasing structural stability of the organizational structure (status hierarchy) of the core of the System (Europe), as well as to the increasing permanence (structural stability) of the 'physical' structure (size distribution of states) of the core of the System: the organizational and physical structures of the System coevolved.

KEY WORDS *Powerful-become-more-powerful effect, Organizational stability, Physical stability, Brittleness, Collapse.*

The powerful-become-more-powerful effect can be explained as follows: The finite-time singularity dynamic the anarchistic System produced during the 1495-1945 period was accompanied by four accelerating cycles. Each cycle consisted of a relatively stable period ('international order') followed by a systemic war.

During systemic wars, consistent with the second law of thermodynamics, free energy (tensions) was put to work to implement upgraded orders, to allow for a lower energy state of the System.

During systemic wars, states collectively designed and implemented the organizational arrangements that underpinned the upgraded international orders.

Dominant states used their position of strength and influence to ensure that these arrangements (especially) promoted their (specific) interests. This they achieved by including 'privilege in the arrangements. These privileges contributed to the structural stability of the international order, and gave (additional) incentives to dominant states to maintain the status quo.

Because successive international orders increasingly reflected the interests of increasingly powerful and influential states, they could further strengthen and consolidate their (already) influential positions during the upgraded international order. The Great Power status hierarchy became increasingly embedded in – and a reflection of – (successive) international orders, and vice versa.

At the same time as the Great Power status hierarchy became more permanent (stable) through the powerful-become-more-powerful effect, the physical structures of the System – the size distribution of states in the System – became increasingly fractal, and permanent.

I assume that the organizational stability and the stability of physical structures in the anarchistic System coevolved, and that both properties were not coincidentally fully developed (fully crystallized) during the fourth international order shortly before the anarchistic System's collapse.

In 1939, the moment the anarchistic System reached absolute structural stability, the System became (what I call) 'brittle', and free energy could no longer be put to work to change its organizational and physical structures, and as a consequence, further energy input caused the anarchistic System to 'break' and collapse. To this condition I also refer to as the anarchistic end state of the System.

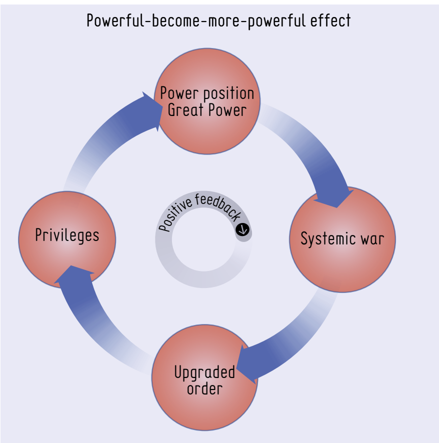


Figure 90
To understand the decrease in Great Power dynamics, it is important to understand the ability of more powerful states to create more favorable international orders that specifically promote their interest. The 'powerful-become-more-powerful effect' is contained in the co-evolutionary nature of the development of Great Powers and successive international orders. Dominant states (Great Powers) were progressively in a more influential position to define the next international order, and successive orders increasingly promoted the position of a select number of states.

123 Because of increasing connectivity, the System became more stable and robust but at the same time also produced accelerating amounts of free energy (tensions). During (especially) high-connectivity regimes of successive international orders, the anarchistic System had to cope with increasingly high tension levels, caused by issues and tensions that could no longer be released through non-systemic wars.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Acceleration, Collapse, Dual-phase transition.*

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), states became increasingly dependent on each other for the fulfillment of their basic requirements, including for their mutual security. Increasing interdependence was accompanied by the production of increasing amounts of free energy (tensions), a consequence of the intrinsic incompatibility of connectivity and security in anarchistic systems. During relatively stable periods 'international orders', had to cope with these increasing tensions in the System; as a consequence, successive international orders contained increasingly comprehensive organizational arrangements in efforts to restrain the increasing levels of insecurity that were inherent in the interdependence of the System.

As the accelerating frequency of systemic wars shows, these efforts ultimately failed, when the System in 1939 reached the critical connectivity threshold (the singularity in finite time), produced infinite amounts of free energy (tensions), and as a consequence collapsed. In response, and consistent with the second law of thermodynamics, the System produced a dual-phase transition.

The production of accelerating tension levels in the anarchistic System and the (almost) absolute robustness of the fourth international order (1918-1939), which was implemented through the third systemic war (the First World War, 1914-1918), explain why this order was highly dysfunctional, and only had a very short life span (consistent with the demands of the second law of thermodynamics). The inability of the fourth international order to ensure the balanced fulfillment of basic requirements of states in the System, especially of their (competing) security requirements, is indicative for its dysfunctionality.

Already during the life span of the fourth international order, historians noted that something was fundamentally wrong with this international order. In a study written in 1939, Carr denoted this period as the 'Twenty Years Crisis' (17).

The dysfunctionality of the fourth international order, signaled the collapse of the anarchistic System and the need for more fundamental change; 'more of the same' was not a viable option any longer.

124 Coevolution of states and international orders reinforced by a 'powerful-become-more-powerful effect' contributed to the structural stability of the System.

KEY WORDS *Powerful-become-more powerful effect, Structural stability, Great Power status dynamics, Great Power status hierarchy, Permanence, Size-distribution of states, Power-law, Fractal structures, Coevolution Collapse, Dual-phase transition.*

I consider the permanence of structures in the System a measure for its structural stability. I distinguish two types of structures: (1) the status hierarchy of the System and its degree of permanence, and (2) the size distribution of states in the System and its permanence.

1 **Great Power status hierarchy**.
Great Power status dynamics and the permanence of the Great Power status hierarchy (which states acquired and maintained Great Power status) are indicative for the (organizational) structural stability of the System. When successive cycles of the finite-time singularity dynamic (1495-1945) are used as the 'unit' of analysis, Levy's data shows (38) that the Great Power status dynamics in Europe decreased linearly over time, and that the Great Power status hierarchy reached 'complete' permanence during the fourth international system (the fourth relatively stable period, 1918-1939. This development means that the organizational stability of the System increased linearly over time, and became 'absolute' during the fourth international order (1918-1939).

2 **The size-distribution of states**.
During the unfolding of the finite-time singularity dynamic, the size distribution of states – the size of territories they controlled – also showed a clear trend, consistent with the (simultaneous) increase in organizational stability of the System: During the unfolding of the finite-time singularity dynamic (1495-1945) the number of states (units) decreased, and their size-distribution stabilized shortly before the System reached the critical connectivity threshold (in 1939). Regarding the number and sizes of European states Tilly observes: "Major consolidations occurred with the formation of the German Empire and the Kingdom of Italy. By the start of 1890, the roster of states had declined to about 30, of which nine were members of the German Empire. At the end of 1918, the count stood at around 25 separate states. Although boundaries changed significantly with the settlements of World Wars I and II, the number and size of European states did not change dramatically during the twentieth century" Tilly (70).
The same time as the number of states in the core of the System (Europe) decreased, their size- distribution could be (increasingly better) described by a power-law (40), implying that the System increasingly crystalized in fractal structures.

Fractality is closely related to the optimization of distribution processes. The fractality of the System's structures is no coincidence; these fractal structures were carved out by the fractal nature of systemic wars. Fractal structures supported the most effective and efficient distribution of destructive energy during systemic wars and minimized the production of tensions during relatively stable periods. Fractality of the System's structures, in other words, contributed to its performance (ability to fulfill the basic requirements of uneven states) and its evolvability (its ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars).

The increasing organizational permanence of the core of the System (Europe), and the simultaneous crystallization in fractal (state) structures – both becoming 'absolute' during the fourth international order (1918-1939), shortly before the anarchistic System's collapse in 1939 – were closely related phenomenon, that (necessarily) preceded the next step in the development (level of integration) in the core of the System: the implementation of two dedicated non-anarchistic hierarchies, through the fourth systemic war (the Second World War, 1939-1945).

At the base of the development of the core of the System towards increasing structural stability, of which the increasing organizational permanence and the simultaneous crystallization in fractal (state) structures are indications, was the coevolutionary development of states and successive international orders in the anarchistic System.

Depending on their power and influence, states could, to a lesser or greater degree, influence the outcome of systemic wars and the organizational arrangements that were embedded in upgraded international orders through these systemic wars. The more powerful and influential a state, the more an international order could (and would) reflect the power and interests of this state, and the more this state would ensure that the new status quo would be maintained.

The coevolutionary development of states and successive international orders constituted a self-reinforcing positive feedback mechanism that can best be described as a 'powerful-become-more-powerful' effect. More powerful states could ensure that more favorable international orders were implemented that enhanced their already more powerful positions, giving them a further advantage during the next systemic war that the anarchistic System would unavoidably develop. This powerful-become-more-powerful mechanism contributed to the organizational stability – the permanence – of the anarchistic System; ultimately it became 'impossible' for states to lose their Great Power status, or for other states to acquire such a status.

125 The increasing inability of the System to release free energy through non-systemic wars – its robustness – increasingly affected the System's fragility and its ability to maintain itself within a certain international order.

KEY WORDS *second law of thermodynamics, Non-systemic wars, Robustness, Fragility, Collapse.*

Successive relatively stable periods (international orders) not only became increasingly stable over time, but also more robust and fragile at the same time.

Robustness determines the sensitivity of the System to perturbing incidents and its ability to avoid producing non-systemic release events (non-systemic wars). The number of non-systemic wars the System produced during successive relatively stable periods (international orders) is a measure of its evolving robustness. War data (38) shows that the number of non-systemic wars decreased linearly during successive cycles, and ultimately reached zero during the fourth international order (1918-1939). This development implies that the robustness of the System increased linearly during the unfolding of the finite-time singularity dynamic, accompanied by four accelerating cycles (1495-1945), and became infinite during the fourth relatively stable period.

The 'degree' of robustness of the anarchistic System determined – 'controlled' – the sizes of non-systemic wars the System produced, and determined in combination with the level of structural stability of the System, the energy state – the level of metastability – of successive international orders (relatively stable periods). Both robustness and structural stability of the System are functions of its connectivity.

When ultimately, during the fourth international order (1918-1939), absolute robustness was achieved, free energy (tensions), could no longer be released through non-systemic wars, but only through systemic wars. This development contributed to the fragility, and to the eventual collapse of the anarchistic System in 1939, when the System (because of its level of connectivity) produced infinite amounts of free energy (tensions).

Fragility is a property of the anarchistic System that determines how long the System can sustain itself within a certain (international) order, before becoming critical and being forced (by the second law of thermodynamics) to implement an upgraded order through systemic war, that again enables a (temporary) lower energy state of the System. The life span of successive relatively stable periods is a measure of the System's fragility; the fragility of the anarchistic System during the 1495-1945 period increased at an accelerating rate and became 'infinite' when the System in 1939 reached the critical connectivity threshold. At that point, the anarchistic System produced infinite amounts of free energy (tensions) and was forced to ('theoretically') implement upgraded orders at an infinite frequency; as a consequence of these unsustainable requirements, the anarchistic System collapsed, and was 'forced' by the second law of thermodynamics to simultaneously implement two dedicated non-anarchistic hierarchies in the core of the System (Europe), and the first global order at a global scale of the System.

Robustness and fragility are closely related properties; two sides of the same coin. By limiting the System's ability to produce non-systemic release events, increasing robustness caused the System to become more fragile 'at the same time'. In case of the anarchistic System, absolute robustness is equivalent with infinite fragility and collapse.

126 When in 1939 the anarchistic System reached the critical connectivity threshold it had become obsolete.

KEY WORDS *Critical connectivity threshold, 1939, Collapse, Robustness, Fragility, Structural stability, Status dynamics.*

When the System reached the critical connectivity threshold (the singularity in finite time) in 1939, it produced infinite amounts of free energy (tensions) and was forced to produce upgraded orders at infinite frequencies. This unsustainable requirement led to the anarchistic System's collapse and dual-phase transition through the fourth systemic war (the Second World War, 1939-1945), consistent with the requirements of the second law of thermodynamics.

A closer look at the properties of the anarchistic System, once the critical connectivity threshold was reached in 1939, shows – explains – the unsustainability of this particular condition.

The moment the anarchistic System reached the critical connectivity threshold, and produced infinite amounts of free energy (tensions), the System's *robustness* and *fragility* both had reached infinite levels. Also, at that point, the *structural stability* of the anarchistic System had become absolute; Great Power *status dynamics* in the core of the System had come to a 'complete' halt, implying Great Power status permanence, and the size-distribution of states in the System had become fractal, implying optimality.

From a functional perspective the limits of the anarchistic System also are evident: When the anarchistic System in 1939 reached the critical connectivity threshold, the System's performance – its ability to fulfill the basic requirements of states – as well as its evolvability – its ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars – had 'collapsed': fulfillment of basic requirements of states, and further development of the anarchistic System had become impossible; the anarchistic System had reached the limits of its viability, and a phase transition was now unavoidable.

127 The development of the structural stability, robustness and fragility of the System during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles, point to the unavoidable collapse of the System, following the fourth international order (1918-1939); in 1939 the anarchistic System's 'brittleness' was absolute.

KEY WORDS *Structural stability, Robustness, Fragility, Singularity dynamic, Collapse.*

Analysis from a 'cycle-perspective' shows that the robustness, fragility and structural stability of the System (successive cycles) increased linearly during the unfolding of the finite-time singularity dynamic (1495-1945). Robustness and fragility are two sides of the same coin (as I explained); increasing robustness contributed to increasing fragility of the System.

The increasing permanence of the Great Power status hierarchy in Europe, and the increasing fractality of states structures, are indicative for the increasing structural stability of the structure(s) of the anarchistic System.

Quantitative analysis of these three properties shows that during the fourth relatively stable period (the fourth international order, 1918-1939) the anarchistic System became 'absolute' robust (and could no longer produce non-systemic energy releases (non-systemic wars) as a consequence), 'absolute' fragile, and 'absolute' stable.

At the same time (1939), when the (structures of the) anarchistic System could not further evolve – and put free energy to work for a 'meaningful' purpose – the anarchistic System produced infinite amounts of free energy (tensions); as a consequence, the anarchistic System collapsed. The condition of the anarchistic System shortly before its collapse in 1939, can be described as 'brittle'; at that point, the anarchistic System's brittleness had become 'absolute', and additional stress (tensions), could not be put to work ('absorbed') by further 'deforming' its structures, and instead caused these structures to fracture.

128 The organizational structure (status hierarchy) and 'physical' structure (size distribution of states) coevolved.

KEY WORDS *Structural stability, Permanence, Great Power status dynamics, Size-distribution of states, Brittle, Collapse.*

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the Great Power status dynamics in Europe (the core of the System) decreased linearly; I consider this development indicative for a linear increase in the organizational permanence – organizational stability – of the anarchistic System. The Great Power status hierarchy of the System became permanent (stable) during the fourth international order (1918-1939).

During the unfolding of the finite-time singularity dynamic the System developed from a sizeable collection of loosely connected and diverse units

(1495) into a highly connected System of about 25-30 standardized states (1939). At the same time as units regrouped and became increasingly 'standardized', the size-distribution of states in the System became increasingly fractal, and could ultimately (1939) be best described with a power law. States in the System, the territories they controlled, made up these fractals.

I argue that fractal structures ensure that tension (free energy) production during relatively stable periods is minimized, and that the deployment of destructive energy during systemic wars is optimized. I consider the development of these fractal structures indicative for the increasing physical permanence – physical stability – of the Anarchistic System.

I assume that the organizational and physical stability of anarchistic System are two closely related – coevolving – properties.

When ultimately, both properties reached 'permanence' and could not further develop/evolve, free energy could not be put to work any longer to change organizational and physical structures; the anarchistic System had become (increasingly) 'brittle', and collapse of the anarchistic System was imminent (1939).

129 Organizational and 'physical' stability of the core of the System are related – coevolving – properties of the anarchistic System, during the 1495-1945 period.

KEY WORDS *Organizational stability, Physical stability, Coevolution.*

A linear decrease in the Great Power status dynamics of the System (1495-1945) implies a linear increase in its 'organizational permanence', in the System's structural stability. However, this was not an isolated development: At the same time as the Great Power status dynamics decreased linearly, the physical structure ('organization) of the System increasingly became fractal. At the start of the finite-time singularity dynamic (1495) the System consisted of a collection of 'hundreds' of loosely connected and (organizationally) diverse units; by the time the finite-time singularity reached the critical connectivity threshold (1939), the anarchistic System had crystalized into a highly connected network of a significant lower number of standardized and interdependent states. At that point, a power law, pointing to the System's fractal – and optimized – structure, could best describe the size distribution of states in the System.

The paradox is that by the time – 1939 – the System reached 'absolute' structural stability, the System collapsed.

130 The increasing structural stability of successive relatively stable periods (international orders) and the increasing totality of successive systemic wars, were related – and interacting – properties of the anarchistic System.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Structural stability, Totality of war, Brittleness, Fracture, Collapse.*

The increasing structural stability of the anarchistic System and the increasing totality of successive systemic wars during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), are related phenomena.

The (linear) decrease of the Great Power status dynamics in the core of the System (Europe) during successive cycles, coming to a complete halt during the fourth relatively stable period (the fourth systemic war, 1918-1939), show that the Great Power status hierarchy – the organization of the System – ultimately (1939) became permanent.

At the same time as the organization of the anarchistic System stabilized, the size-distribution of states in the System became increasingly fractal, and ultimately (also in 1939, or shortly before) could be best described with a power-law. The fractality of the physical structures of the anarchistic System points to optimization.

I consider the organizational and 'physical' permanence – structural stability – of the anarchistic System indicative for its 'overall' structural stability; I also assume that connectivity is the (indirect) driver of both properties.

At same time as the structural stability of the anarchistic System increased step-by-step, 'systemic war-by-systemic war', successive systemic wars became increasingly total: ultimately complete populations and societies were mobilized to ensure the production and deployment of sufficient amounts of destructive energy; as a consequence, populations and societies also became 'legitimate' targets. The fact that systemic wars were 'necessary' at an accelerating rate (to ensure consistency of the System with the second law of thermodynamics), and that accelerating amounts of destructive energy were – and had to be – deployed during successive systemic wars, were a direct consequence of the accelerating amounts of free energy (tensions) the anarchistic System produced.

However, the increasing structural stability of successive relatively stable periods (international orders) also is a relevant factor in this respect: more stable systems, require more energy input to accomplish changes in its (internal) structure; the System is no exception on this rule.

The structural stability of the anarchistic System can also be considered a measure for its brittleness, its ability to absorb energy before fracturing. Increasing structural stability, implies a decreasing ability of the System to 'absorb' energy; to put energy (tensions) to work to change its organizational or physical structures.

The absolute structural stability of the System during the fourth relatively stable period (the fourth international order, 1918-1939), means that its brittleness had become absolute and that its 'energy absorption potential' was now depleted. Energy (input) could no longer be absorbed and be put to work in a 'sensible' way; but energy input could also not be avoided. As a consequence, the anarchistic System fractured – collapsed – in 1939, when the critical connectivity threshold was reached.

131 The accelerating dynamics of successive cycles are self-reinforcing. Successive orders produce increasing levels of tensions and must be increasingly robust to meet the demands of the second law of thermodynamics; increasing robustness goes hand in hand with increasing fragility and shorter life spans.

KEY WORDS *Self-reinforcement, Cycles, second law of thermodynamics, Robustness, Fragility.*

Increasing connectivity – interdependence – and security are intrinsically incompatible in anarchistic Systems. The degree of connectivity (interdependence) of states in the System determines the amount of free energy (tensions) it produces. The order of the System determines its structural stability, robustness, and fragility. Increasing levels of free energy require increasing levels of order that are implemented – 'enforced' – by the second law of thermodynamics to meet its demands.

Although successive orders are more stable and robust, allowing for a lower energy state, successive orders also are more fragile, at the same time. Larger amounts of free energy can be restrained by successive orders without being released through non-systemic wars, but this increased ability to suppress non-systemic wars comes at a price: life spans of successive orders become increasingly shorter at an accelerating rate. Instead of being released, tensions are stored and crystallize in underlying vulnerable issue clusters that eventually percolate the System and cause it to become critical. Successive orders execute this process at increasing rates.

Connectivity through population growth drives the System. At the same time as successive orders can and must become more stable and robust to ensure fulfillment of basic requirements of states, successive orders also become more fragile. Accelerating cycles that accompany finite-time singularities are self-reinforcing (see also (33) and (34))

7 PHASE TRANSITIONS

132 Numerous indicators suggest that the core of the System experienced a phase transition through the fourth systemic war (the Second World War, 1939-1945).

KEY WORDS *Fourth systemic war, Core, Phase transition, Indicators.*

The phase transitions the core of the System in Europe experienced through the fourth systemic war (the Second World War, 1939-1945) was produced by the finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the period 1939-1945.

The phase transition was already announced through a number of precursory 'dynamics', including various critical phenomenon that could be observed. These precursory indicators include:

1) The fundamentally different structures of the core of the System before and after the phase transition from a decentralized network of independent nodes to hierarchical structures.

2) The fundamentally different behavior of the System before and after the phase transition from anarchistic to cooperative within the two dedicated hierarchies the System produced.

3) The typical behavior and dynamics that can be observed in the core of the System (Europe) during the phase transition and during preceding systemic wars (periods of criticality): infinite susceptibility of the System, system-wide communication, coordination, and planning. These properties and dynamics are indicative of criticality and prerequisites for the design and implementation of upgraded orders.

4) The simultaneous acceleration of the frequency of systemic wars and their amplitudes (severities) towards infinity at the critical connectivity threshold.

5) The simultaneous infiniteness of the robustness and fragility of the System at the critical connectivity threshold, consistent with its imminent collapse.

6) The maximal structural stability the core of the System reached in 1939. Both Great Power status dynamics and border changes came to a halt shortly before the collapse of the anarchistic System in 1939, respectively signaling organizational and structural permanence of the System at that point in time.

7) Changes in energy transfers (patterns of distribution) in the anarchistic System

8) The conceptual consistency of the dynamics of the System and its properties.

133 A dual-phase transition was the response of the System – of the second law of thermodynamics – to the (ultimately) infinite amounts of free energy (tensions) the System produced when it reached the critical connectivity threshold in 1939.

KEY WORDS *Dual-phase transition, second law of thermodynamics, Free energy, Critical connectivity threshold, Collapse.*

When the anarchistic System reached the critical connectivity threshold in 1939, the incompatibility between connectivity and security had become infinite. At the critical connectivity threshold, the anarchistic System could not produce a viable order that could be sustainable in the anarchistic System and, the anarchistic System collapsed.

In response to this condition, the System – consistent with the second law of thermodynamics – produced a phase transition (through the fourth systemic war, the Second World War, 1939-1945). This phase transition had two (closely related) impacts: (1) the implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and (2) the simultaneous implementation of the first global order at a (now) global scale of the anarchistic System. Both upgraded orders contributed to a (temporary) lower energy state of the System, that allowed (and still allows) for a new period of growth.

134 To ensure compliance with the second law of thermodynamics, increased levels of order were simultaneously implemented through a phase transition (1939-1945) in the core and non-core of the System.

KEY WORDS *second law of thermodynamics, Compliance, Upgraded orders, Dual-phase transition, Core, Non-core, Liking pins.*

Political control of core states over non-core territories and state-like structures they had established, and (increasing) involvement of non-core states (especially the United States) in internal core (European) dynamics, ensured that core- and non-core dynamics increasingly interacted. The non-core not only expanded, developed its own autonomous dynamics, but also increasingly interacted with core (European) dynamics.

These developments and dynamics impacted on the production of free energy (tensions) in the System: the 'total' amount of free energy not only increased because of the increasing incompatibility of connection and security in the core of the System (Europe), that now also 'overflowed' - to the non-core, but also because of mutual rivalries between non-core states, and between non-core and core states. These 'combined' effects evoked a dual – and coordinated – response from the second law of thermodynamics.

The moment in 1939 when the core of the System in Europe reached the critical connectivity threshold and produced infinite levels of free energy (tensions), it also created tensions in the non-core because of the (increasing) overlap of core and non-core. As a consequence of these interacting dynamics and free energy transfers, underlying vulnerable issue clusters in Europe and Asia became connected, and the System in 1941 became critical and reached a percolation condition at a global scale.

The (contingent) decision of Germany to declare war on the United States when Japan, Germany's ally, attacked the United States in Pearl Harbor (1941), linked both European and Asian clusters, and caused the System to become critical at a global scale. The connection of both theaters of war in 1941 and, therefore, of both underlying vulnerable issue and war clusters, into a global cluster was only a matter of time. In December 1941 the underlying vulnerable issue clusters (situated in Europe and Asia) had almost percolated the entire global System and Germany's decision provided the decision-makers in the United States, led by President Roosevelt, with justification to switch to a positive war decision not only regarding Japan, but also regarding Germany. This was because of the interests that were at stake for the United States in Europe. The core of the System (Europe) already had become critical in 1939; the global System became critical in 1941. Global criticality and global systemic war allowed for global communication, coordination, and planning, necessary for the design of a global international order.

Because of the overlap of core and non-core, their actual integration, and the fact that the distinction between core and non-core had lost meaning, upgraded orders had to be implemented simultaneously in Europe and at a global scale. Through a dual-phase transition (the fourth systemic war, The Second World War, 1939-1945) - consistent with the second law of thermodynamics - the System simultaneously implemented dedicated non-anarchistic hierarchies in Europe (the core of the System), and the first global order at a global scale of the (now) global anarchistic System.

If the implementation of both orders had not been synchronized and coordinated in practical terms, compliance with the second law of thermodynamics and structural stability could not have been accomplished in System.

135 The merger of the core (Europe) and non-core of the System through the dual-phase transition (the fourth systemic wars, the Second World War, 1939-1945) was accomplished through the 'overlap' between core and non-core before and after the dual-phase transition.

KEY WORDS *Core, Non-core, Merger, Dual-phase transition, Fourth systemic war, Overlap, Linkage.*

The non-core of the System started off as an extension of European dynamics outside of Europe itself, the core of the System. The core and non-core initially had their own dynamics that over time became increasingly synchronized. During the fourth systemic war (the Second World War, 1939-1945) both dynamics became completely synchronized and the distinction between core and non-core lost its meaning.

The fourth systemic war constituted a dual-phase transition: simultaneously two dedicated non-anarchistic hierarchies and a first global international order were implemented, in respectively the core of the System (Europe), and at a global scale of the now global anarchistic System. Both upgraded orders were a response to the demands of the second law of thermodynamics and were (and probably still are) inseparable linked.

The overlap between core and non-core was instrumental in the accomplishment of the dual-phase transition. It is important to distinguish between the overlap of core and non-core, preceding the phase transition (1939-1945), and following its implementation.

1 **Overlap of core and non-core preceding the phase transition**.
Preceding the phase transition, overlap – synchronization – of core and non-core was achieved through political control of core (European) states over non-core territories. "European states held political control over about 7 percent of the earth's land in 1500, 35 percent in 1800, and 84 percent in 1914" (70).

2 **Overlap of core and non-core following the phase transition**.
Through the fourth systemic war (the phase transition) the United States and the Soviet Union established political control over Europe and also achieved dominant positions at a global level of the System. Both Great Powers were dominant in the (erstwhile) core and non-core, and could determine the upgraded orders that were established. This overlap, ensured a coordinated response concerning both orders that were implemented.

136 The second law of thermodynamics determined the merging of the core and non-core of the System and the simultaneous establishment of upgraded orders in Europe and at a global scale of the System.

KEY WORDS *second law of thermodynamics, Merging, Core, Non-core, Dual-phase transition.*

The second law of thermodynamics determined and shaped free energy transfers (transfers of tensions) between core and non-core preceding the phase transition precipitated by the fourth systemic war (1939-1945), as well as the aggregation and full integration of core and non-core. A shift in the centrality of nodes at a global level, effectuated during the fourth systemic war (the Second World War, 1939-1945), was at the heart of the phase transition experienced by the global System. Only by simultaneously establishing upgraded orders in Europe (the erstwhile core), and at a global level of the now global anarchistic System, could the energy state of the System be lowered and comply with the second law of thermodynamics.

137 The fourth systemic war (the Second World War, 1939-1945) qualifies as a dual-phase transition.

KEY WORDS *Fourth systemic war, Dual-phase transition, Dedicated non-anarchistic hierarchies, First global order.*

When the critical connectivity threshold of the anarchistic System was eventually reached in 1939, the core of the System experienced a critical period for the fourth time since the inception of the finite-time singularity dynamic in 1495.

Through the first three systemic wars – respectively 1618-1648 (the Thirty Years' War), 1792-1815 (the French Revolutionary and Napoleonic Wars), and 1914-1918 (the First World War) – the System implemented upgraded orders, that were (still) able to reconcile the increasing levels of connectivity of the anarchistic System, and the amounts of free energy they implied, with the structural stability that could be accomplished through these orders, necessary for the collective fulfillment of basic requirements of the uneven states that constituted the anarchistic System.

When the critical connectivity threshold was reached in 1939, however, the System produced infinite levels of free energy and tensions, and connectivity and security of the anarchistic System had become irreconcilable. The anarchistic System collapsed as a consequence, and produced a dual-phase transition. The second law of thermodynamics demanded the dual-phase transition, to ensure compliance of the System with the law's requirements.

The dual-phase transition consisted of two 'components' to achieve this: (1) the implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), resulting in the neutralization of anarchy and free energy production in respective hierarchies, and (2) the simultaneous implementation of a first global international order at a global scale of the anarchistic System. Both upgraded orders – at least temporarily – contributed to a lower energy state of the now global anarchistic System.

138 Before and after the dual-phase transition (1939-1945), the System shows fundamentally different behaviors that can be related to a change in the internal dynamics of the System.

KEY WORDS *Dual-phase transition, Fundamental change in behavior, Dedicated non-anarchistic hierarchies, First global order, Merging.*

Typically for phase transitions, a system shows fundamentally different behavior before and after experiencing a phase transition.

Through the fourth systemic war (the Second World War, 1939-1945) the System experienced a dual-phase transition; resulting in the simultaneous implementation of two dedicated non-anarchistic hierarchies in Europe, the core of the System, and the first global order at a global scale of the System.

The dual-phase transition in fact marks the merging of the core and the non-core of the System.

Both orders were (are) complementary; the 'European order' is an integral component of the first global order.

The behavior of the System changed in a number of respects before and after the dual-phase transition:

1) Implementation of two dedicated non-anarchistic hierarchies, that merged into one in 1989 after the collapse of the Eastern hierarchy.
2) Implementation of a first global order at a global scale, ensuring the regulation of interactions between states.
3) Merging of core (Europe) and non-core of the System into one coherent (anarchistic) System.

139 Because of a lack of data, I cannot proof – as I assume is the case and is in accordance with typical critical behavior – that the distribution of cluster sizes at critical points of the anarchistic System (just before and during systemic wars) can be best described by a power law.

KEY WORDS *Criticality, Fractals, Systemic wars, Power-laws.*

With clusters I am referring to issues, sub-wars, military campaigns, and battles. Such proof would – as I already mentioned – strongly support my phase transition hypothesis.

I argue that the fractal structures the anarchistic System eventually acquired (shortly before its collapse in 1939) were carved out by the fractal nature of preceding systemic wars; these fractal structures – the fact that the size distribution of states can be best described by a power law – in fact are indicative for the System's periodic criticality.

The power law that I did identify concerns the size distribution of non-systemic wars that occurred during 1495–1945. This power law is not indicative of criticality; the System was not continuously in a critical condition during that period of time. This power law was produced because non-systemic war dynamics were chaotic and (temporarily) periodic in nature. Chaotic non-systemic war dynamics are deterministic, but also highly unpredictable because of their sensitivity for the initial conditions of the System.

140 The effect of the dual-phase transition (the fourth systemic war, the Second World War, 1939-1945) constituted a next step in a long-term process of social integration and expansion (SIE) in Europe and the System.

KEY WORDS *Dual-phase transition, SIE, Core, Non-core, Merging.*

The phase transition the System experienced through the fourth systemic war (the Second World War, 1939-1945) consisted of two complementary components: a 'European' and global component. Both phase transitions were inseparably linked; 'each' particular phase transition – respectively in Europe, and at a global scale – could not have been accomplished without the other.

Through the dual-phase transition, two dedicated non-anarchistic hierarchies were implemented in Europe (in the core of the System), and a first global international order at a global scale of the System. Both complementary orders ensured that the (now) global System complied with the requirements of the second law of thermodynamics.

The implementation of two dedicated non-anarchistic hierarchies in Europe led to the neutralization of anarchy, and an end to the production of free energy (tensions), within respective hierarchies, and can be considered a next step in a long-term process of integration in Europe. The first global international order ensures that interactions between states in the now global anarchistic System are more or less regulated, and tensions can be somewhat controlled.

The dual-phase transition marks the merging of the core (Europe) and non-core of the System. Since the merging of core and non-core the long-term process of integration in the System, is plays out at a global scale.

8 CHAOTIC AND NON-CHAOTIC NON-SYSTEMIC WAR DYNAMICS.

141 By default, non-systemic war dynamics are chaotic in nature.

KEY WORDS *Chaotic non-systemic war dynamics, Degrees of freedom.*

Although the dynamics of chaotic systems are completely deterministic, they fluctuate irregularly and are never exactly repeated. The trajectories of the sizes and intensities of non-systemic wars approach what is called a strange attractor. Chaotic systems have sensitive dependence on initial conditions. Two nearby trajectories in state space diverge exponentially, making accurate predictions about trajectories in state space, in this case about the size and intensity of non-systemic wars, is, by definition, very inaccurate. Despite these irregularities, the nonlinear nature of non-systemic war dynamics, and their sensitive dependence on initial conditions, the trajectories of chaotic war dynamics are bound to a certain region in state space. Their bounded trajectories make chaotic non-systemic war dynamics are more restrained, but unpredictable at the same time.

This study shows that non-systemic war dynamics for chaotic systems follow typical circular trajectories in state space defined by size and intensity. They have sensitive dependence on initial conditions, their trajectories diverge exponentially, as the calculation of Lyapunov exponents shows, and they are bounded in state space. The size-distribution of non-systemic wars is best described by a power-law for chaotic systems.

Furthermore, periodic non-systemic war dynamics that developed during the exceptional period (1657-1763), and that can be attributed to a decrease in the number of degrees of freedom in the System (from $n > 2$ to $n = 2$), further support the assumption that non-chaotic war dynamics are by default chaotic.

142 The trajectories in phase state of war dynamics show positive Lyapunov exponents, which points to chaotic dynamics.

KEY WORDS *Chaotic war dynamics, Lyapunov exponent.*

To calculate the Lyapunov exponents of the war dynamics of the System, I have selected two pairs of wars (designated as serial 1 and serial 2), of which the initial conditions in phase state (their respective sizes and intensities) are close to one another. I consider the point at which these two wars show nearly similar conditions (size and intensity values) the origin of both trajectories.

However, a note of caution must be made; although the initial conditions for size and intensity are more or less approximate in phase state, in 'time of occurrence,' they differ significantly. The start time of the respective wars (i.e., pair 9–36 (serial 1) and pair 9–39 (serial 2)) are 74 and 87 years apart, respectively. As a consequence, both trajectories of a single pair were subject to different levels of 'noise' (stochastic factors). I assume that noise only had a limited impact on the deterministic nature of non-systemic wars. Serials 1 and 2 concern war numbers 9 and 39 and war numbers 9 and 36, respectively. Next, I have determined λ for: |ΔI(t)| = |ΔI(0)|e^λ(t).

Pairs with initial conditions			
Serial	Pair	Start value size, both wars	Start value intensity (/1000), war 1 and war 2
1	9–39	0.20	0.057 and 0.024
2	9–36	0.20	0.057 and 0.049

Table 81 *This table provides information on the selected pairs with almost similar initial conditions.*

Serial 1: Lyapunov exponent ≈ 1,02				
t	9	39	Abs |9-39|	λ
0	0.057	0.024	0.033	NA
1	0.043	0.127	-0.084	0.93
2	0.42	0.149	0.271	1.05
3	0.958	0.003	0.955	1.12
4	0.041	1.685	-1.644	0.98

Table 82 *This table shows the data used for the calculation of the Lyapunov exponent of serial 1. The Lyapunov exponent = 1.02.*

Serial 2: Lyapunov exponent ≈ 2,51				
t	9	36	Abs |6-36|	λ
0	0.057	0.049	0.008	NA
1	0.043	0.195	-0.152	2.94
2	0.42	1.086	-0.666	2.21
3	0.958	0.024	0.934	2.38

Table 83 *This table shows the data used for the calculation of the Lyapunov exponent of serial 2. The Lyapunov exponent = 2.51.*

These two pairs show a positive Lyapunov exponent, which points to chaotic dynamics. The values of the separate exponents are in relatively close proximity, particularly when different noise levels are taken into account. Not all wars (pairs) in close proximity in the phase state have positive Lyapunov exponents. These results are, however, encouraging, assuming the war dynamics are chaotic, as I propose.

Apart from visual similarities in the attractor of the non-systemic war dynamics and of confirmed chaotic dynamics, there are positive Lyapunov exponents for the two pairs of initial conditions. Abnormal war dynamics during the exceptional period also shed light on the characteristics of the non-systemic war dynamics.

143 By default, non-systemic war dynamics are chaotic in nature; the number of degrees of freedom in the System determines the nature of its non-systemic war dynamics.

KEY WORDS *Nature of non-systemic war dynamics, Degrees of freedom, Chaotic non-systemic war dynamics, Exceptional periods, Rivalry, Hyper-excited, Subdues war dynamics.*

The intensity of rivalries between Great Powers in the System determines, how many other states (other than the rivals) decision makers take into consideration regarding war decisions. The number of states that are taken into consideration, determines the number of degrees of freedom (n) of the System. During periods of intense rivalry between two Great Powers, all issues in the System become related to this rivalry; the rivalry results in an 'over-connection' of their issues, and affects the structure and dynamics of the (underlying) vulnerable issue clusters that form in the System, and wars that are produced. In the case of intense rivalry between two states, the number of degrees of freedom is reduced to only two.

During the period 1495 – present, this – intense rivalries that impacted on the war dynamics of the System by reducing the System's degrees of freedom to two - happened two times: during (what I for that reason designate as) the first exceptional period (1657-1763), because of the intense rivalry between Great Britain and France, and during a second exceptional period (1953-1989), because of the intense rivalry between the United States and the Soviet Union, and the respective hierarchies they controlled (better known as the "cold War').

Intense rivalry leads to over-connection of issues (and states) and the System's dynamics become hyper-excited as a consequence. During the first exceptional period, non-systemic war dynamics were periodic in nature. They were more regular, more predictable, more severe/intense, and larger in size, than ('default') chaotic non-systemic war dynamics the System normally (when $n > 2$) produces.

Because of its hyper-exited state, the System during the first exceptional period also produced a number of system-sized non-systemic wars, that however not qualify as systemic; as explained, systemic wars not only are system-wide, but have certain properties that allow this type of wars to collectively design and implemented upgraded orders in the System. The system-sized 'abnormal' wars during the first exceptional period, did not meet these requirements

During the second exceptional period (1953-1989, the Cold War) the non-systemic war dynamics of the System were temporarily highly subdued. During this period of time both superpowers, the United States and the Soviet Union, and the respective dedicated hierarchies they controlled, were 'absolute' interdependent regarding their (mutual) security. This condition was reached through the ability of both superpowers to launch a second nuclear strike, under all conditions. A second-strike capability gave each superpower the ability to destroy the other in response to a first nuclear strike of its adversary; both the United States and the Soviet Union had assured that sufficient nuclear weapons and delivery systems could survive a first nuclear strike, that assured the destruction of its rival in response. This 'condition' is in nuclear strategy terminology also referred to as MAD: mutual assured destruction.

This situation can be considered the 'ultimate' deadlock: War – as a rational instrument of politics/policy – was obsolete during the second exceptional period. War would escalate, and result in mutual assured. This deadlock explains why the eight non-systemic wars (see table 31) the System produced during this period only involved one Great Power (except for the Sinai War, 1956, nr. 117), and occurred outside of Europe (except for the Russo-Hungarian War, 1956, nr. 116).

When the Eastern hierarchy collapsed (1989), the deadlock was resolved, the number of degrees of freedom in the System increased (n > 2), and the System resumed chaotic dynamics.

144 The Lyapunov exponents of trajectories of non-systemic war dynamics suggest that these dynamics are chaotic.

KEY WORDS *Chaotic war dynamics, Properties, Trajectories, Phase state, Lyapunov exponent, Intrinsic unpredictability, Circular trajectories, Orbits.*

A typical characteristic of chaotic dynamics is their sensitive dependence for initial conditions. In case of chaotic dynamics, two similar but not identical initial conditions develop differently, producing two completely different exponentially diverging trajectories in phase state. Sensitive dependence for initial conditions makes accurate predictions impossible.

The Lyapunov exponent is a measure of the rate of spread of two trajectories that originate from similar initial conditions. "The Lyapunov exponent is defined as the average rate of trajectory divergence caused by the endogenous component (and not by stochasticity), using for its calculation two trajectories that start near one another and that are – this is an important assumption – affected by an identical sequence of random shocks" (29). A positive exponent is an indicator of chaos.

The System produced positive exponents, this is a further indication of the chaotic nature of non-systemic war dynamics of the System. Other indicators for the chaotic nature of non-systemic war dynamics are circular trajectories of variables in state space, the bounded nature of non-systemic war dynamics, and the switch of non-systemic war dynamics to periodic dynamics when the number of degrees of freedom of the System is reduced to two.

145 In case of chaotic war dynamics – when the number of degrees of freedom (n) in the System is at least three (n > 2) – the war dynamics of the System are more restrained; Chaotic conditions have the effect of an internal control mechanism.

KEY WORDS *Degrees of freedom, Chaotic war dynamics, Internal control mechanism.*

In case of chaotic war dynamics, when n > 2, decision makers of states take at least three states into consideration regarding war decisions. In case the System is 'governed' by two degrees of freedom (n = 2) however – as was the case during two exceptional periods the System experienced as a consequence of intense rivalries between two dominant Great Powers in the System (respectively between Britain and France during the first exceptional period (1657-1763), and the United States and the Soviet Union during the second exceptional period (1953-1989)) – only two other states (the dominant rivals) are taken into consideration; all issues in the System are than (in)directly related to this rivalry.

In case of only two degrees of freedom, the System and its dynamics were more transparent, easier to understand, and (as a consequence) more predictable; hedging of risks was not considered necessary or wise to do under those circumstances, and the System's dynamics became more extreme as a consequence; either more extreme 'upward' (hyper-excited during the first exceptional period), or more extreme 'downward' (highly subdued during the second exceptional period). Chaotic conditions (n > 2) on the other hand, resulted in more restrained (balanced) non-systemic war dynamics; not too extreme, and not too subdued. In case of three degrees of freedom states are more reluctant to engage in war, because of the greater unpredictability of the System under those particular (chaotic) conditions: Unpredictability is synonym for risk and results in restraint.

Chaotic conditions (n > 2) in fact provided the anarchistic System with an 'internal control mechanism' that ensured that non-systemic war dynamics did not become hyper-excited, or too subdued. Chaotic conditions – and chaotic non-systemic war dynamics it resulted in – allowed the System to grow (crystallize) underlying vulnerable issue clusters with fractal structures (especially during high-connectivity regimes of relatively stable periods), that caused the System to eventually become critical, produce systemic wars, and upgrade its order to allow for a lower energy state (tensions) of the System.

Non-chaotic conditions (n = 2) hampered the development of the System, by delaying the development and unfolding of the finite-time singularity dynamic, accompanied by four accelerating cycles (1495-1945), as I discussed in this study.

The impact of the number of degrees of freedom on the properties of non-systemic war dynamics			
Degrees of freedom (n)	Properties of non-systemic war dynamics	Period	Remarks
n = 2	Hyper-excited	First exceptional period (1657-1763)	
n > 2	Restrained/balanced	All other periods, except for systemic wars	Only n > 2 (restrained) non-systemic war dynamics allow for growth of underlying vulnerable issue clusters with fractal structures that cause criticality (systemic war)
n = 2	Subdued	Second Exceptional period (1953-1989)	

Table 84 *This table shows the relationship between the number of degrees of freedom in the System, and properties of non-systemic war dynamics*

146 Chaotic non-systemic war dynamics are necessary for the anarchistic System to reach a high-connectivity regime and become critical, and for the singularity dynamic to develop and unfold.

KEY WORDS *High-connectivity regime, Chaotic war dynamics, Free energy release deficit, Crystallization, Criticality, Exceptional period, Degrees of freedom.*

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the non-systemic war dynamics of the System normally were chaotic in nature; only during the first exceptional period (1657 - 1763) were non-systemic war dynamics not chaotic nature but periodic instead. The number of degrees of freedom (n) of the System determines the nature of its dynamics. The intensity of the rivalries between Great Powers determines the number of degrees of freedom of the System. Normally, states take at least three other states into consideration regarding war decisions (n > 2); at least three degrees of freedom result in chaotic non-systemic war dynamics, that are 'intrinsically' controlled (by the degrees of freedom of the System).

In cases of very intense rivalries between Great Powers (as occurred during the first exceptional period (1657-1763) between Great Britain and France, and during the second exceptional period (1953-1989) between the United States and the Soviet Union) states only take two other states into consideration regarding war decisions (n = 2). During the first exceptional period, as a consequence of intense rivalries, issues between Britain and France became over-connected and non-systemic war dynamics hyper-excited; non-systemic wars were either more extreme (in size and intensity) or completely suppressed, than is the case during chaotic (n > 2) conditions.

This study suggests, as I already mentioned, that the number of degrees of freedom of the System determine how the level of free energy of the System is regulated. Chaotic conditions ($n > 2$) ensure that free energy levels of the System stay within certain boundaries. Chaotic conditions prevent the System from becoming hyper-excited, through (at least) a third degree of freedom. When $n = 2$, free energy levels (tensions) in the System are significantly elevated.

The war data (38) shows that during the first exceptional period (1657 - 1763), the System produced a series of very severe non-systemic wars. Although these wars were system-wide, they did not qualify as systemic and were not indicative of a critical condition of the System. They also did not result in the implementation of a new upgraded order.

During the first exceptional period the System was in a low-connectivity regime, and its dynamics were (also) not restrained by the local stability of states derived from their high connectivity to the network of issues; there was – so to say – only one issue: the intense rivalry between Britain and France.

In 1763, when the intense rivalry between Britain and France was through the Seven Years' War decided in favor of Britain, the System immediately resumed chaotic non-systemic war dynamics, that did not lack 'internal inhibition'. From that moment onwards, a third degree of freedom again impacted the decision-making of states. The resumption of chaotic non-systemic war dynamics is visible in the war data – wars became smaller in size and severity – and in the circular trajectories (orbits) in phase state of the intensities and sizes of non-systemic wars (1763-1792).

Because of the hyper-excited state of the System during the first exceptional period (1657-1763) and the immediate free energy releases of the System through non-systemic wars, the System could not reach a high-connectivity regime, start building up a free energy release deficit, and produce vulnerable issue clusters with fractal structures that could percolate the System, cause criticality, and result in systemic war. Chaotic dynamics and a high-connectivity regime (a regime when increasing connectivity of states in the issue network, inhibit non-systemic release events) are necessary pre-conditions for the System to become critical, and be able to implement upgraded orders.

In other words, issues and tensions that are immediately resolved when they are created, as was the case during the first exceptional period, do not contribute to the development of the System. The abnormal periodic hyper-excited war dynamics during the exceptional period caused a delay in the unfolding of the singularity dynamic and led to the production and use of very high levels of free energy, without significant effects on the development of the System.

147 Orbits in phase state constitute coherent 'war clusters' that perform a balancing function.

KEY WORDS *Phase state, First international order, Chaotic war dynamics, Orbits, Damped oscillator.*

In phase state, dynamics of chaotic systems show complicated trajectories. These trajectories and their boundaries result from so-called strange attractors of these types of systems. These complicated trajectories are the outcome of a few variables that interact nonlinearly. When a phase state is constructed for the war dynamics of the System based on the fraction (relative size) and intensity of successive wars, it is possible to identify (more or less) circular trajectories (i.e., orbits). Orbits can follow either left-handed or right-handed trajectories. In below figure, the right-handed orbits are projected on the left side (second quadrant), and the left-handed orbits are shown on the right side (first quadrant). The data also show that, at certain points in time, non-systemic wars do not follow these circular trajectories. Apart from the exceptional period, these are only short interruptions.

The figure below shows nine orbits – circular trajectories – in phase state of 45 non-systemic wars during the period between 1495–1618, the first relatively stable period preceding the Thirty Years' War.

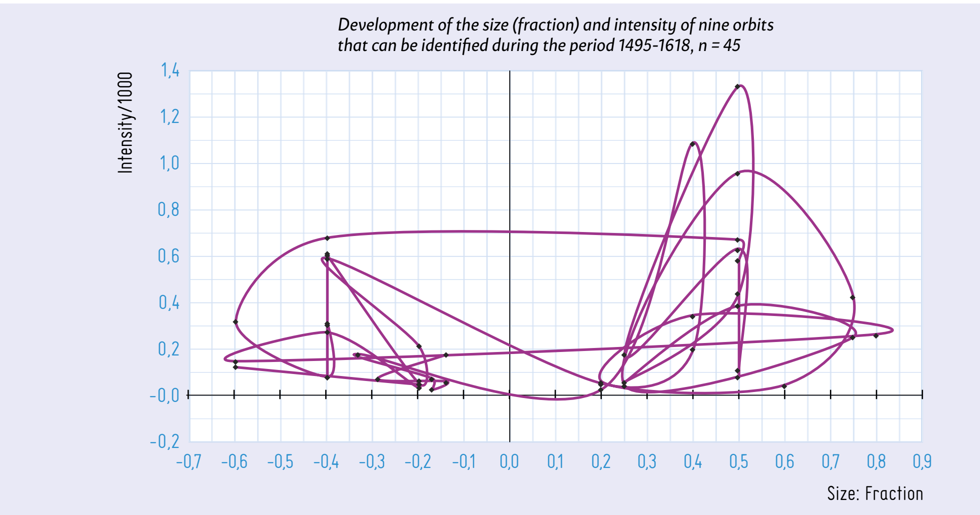


Figure 91 *This figure shows the nine orbits (circular trajectories) the anarchistic System produced in phase state (with size (fraction) and intensity as variables) during the first relatively stable period (the first international order, 1495-1618). In the first quadrant, the orbits with a left-handed direction are shown. In the second quadrant, right-handed orbits are shown. I have constructed this 'attractor' by visually identifying circular orbits in phase state and determined whether these trajectories follow a left-handed or right-handed trajectory. Next, I have projected the right-handed trajectories in the second quadrant.*

Further analysis reveals that orbits ***not*** *develop arbitrarily; these groupings develop with a certain regularity. These typical orbits exhibit visual similarities with strange attractors, which is typical for chaotic systems.*

As I explain in in this study, these orbits are not just 'artificial' constructs: The nine orbits during the first international order constitute a damped oscillator.

148 Chaotic non-systemic war dynamics and high-connectivity regimes are preconditions for the System to become critical.

KEY WORDS *Chaotic war dynamics, Non-chaotic war dynamics, Exceptional periods, High-connectivity regime, Preconditions, Criticality.*

The non-systemic war dynamics during the second relatively stable period (1648-1792) that includes the first exceptional period (1657-1763) reached its tipping point in 1774, shortly after the System resumed chaotic war dynamics.

The period from 1763 until the French Revolutionary and Napoleonic Wars (the second systemic war, 1792-1815)) was a relatively quiet period with only minor conflicts (57). The relatively peaceful conclusion of this life cycle, as is the case with other cycles, is consistent with the characteristics of cascade dynamics that typically precede global cascades (72). The fact that the exceptional period (1657-1763) was situated in the low connectivity regime, where connectivity rather than local stability effects (as is the case in the high-connectivity regime) determine the size of non-systemic wars, is probably not a coincidence.

I argue that high-connectivity regimes and chaotic non-systemic war dynamics are preconditions for the anarchistic System to become critical and produce systemic wars.

During high-connectivity regimes, states become as a consequence of the increasing connectivity of the issue network they are integral parts of, increasingly stable, while at the same time the production of free energy (tensions) further accelerates. Instead of being released (through non-systemic wars) the free energy (unresolved issues and accompanying tensions) are then 'stored' in the System, and crystalize in vulnerable issue clusters with fractal structures, that eventually percolate the System, cause it to become critical and produce a systemic war to upgrade its order.

Chaotic war dynamics (chaotic conditions, $n > 2$), also are a precondition for criticality. Chaotic war dynamics are more restrained than non-chaotic war dynamics, as the extreme periodic war dynamics during the first exceptional period show (1657-1763). Periodic war dynamics do not allow for a high-connectivity regime, the storage of tensions (because they are released) and the formation of vulnerable clusters with fractal structures.

149 Analysis of autocorrelations of non-systemic war dynamics during the first international order (1495-1618) and the first exceptional period (1657-1763) confirms the fundamentally different nature of non-systemic war dynamics during respective periods.

KEY WORDS *Autocorrelation, First international order, First exceptional period, Random versus periodic.*

Autocorrelation is the cross-correlation of a signal with itself. It is a method to detect non-randomness.

In below table the autocorrelations lag-1 until lag-8 are shown of the sizes (in terms of fraction) of wars during the first international order (1495-1618), and of wars during the first exceptional period (1657-1763).

This analysis shows (1) the significant lower and more random autocorrelations during the first international order, and (2) the significant higher and regular autocorrelations during the first exceptional period.

These findings are consistent with the assumption that during the first international order non-systemic war dynamics are chaotic in nature, and during the first exceptional period non-chaotic and more regular.

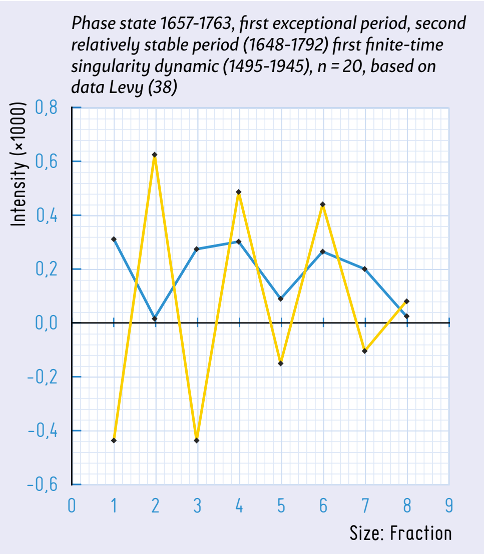


Figure 92
This figure shows the development of lag-1 until lag-8 autocorrelations of war dynamics during the first international order (blue) and the first exceptional period (yellow). During the first exceptional period the autocorrelations were significantly higher and developed more regularly, consistent with the assumption that these 'abnormal' war dynamics were not chaotic, but periodic in nature. During the first international order the System produced 45 non-systemic wars; I calculated the lag-1 autocorrelation of this series of wars by determining the correlation coefficient between the sizes (fraction) of wars 1-44 with 2-45, the lag-2 autocorrelation by determining the correlation coefficient between the sizes of wars 1-43 with 3-45, etc.

150 Multiple indicators point to the chaotic nature of non-systemic war dynamics of the System.

KEY WORDS *Chaotic war dynamics, Proof, Circular trajectories, Orbits, Lyapunov exponent, Degrees of freedom, Exceptional periods, Autocorrelation, Deterministic dynamics.*

I argue that the typical circular trajectories in phase state, the positive Lyapunov exponents that can be found, the abnormal war dynamics that seem to be related to a decrease in the number of degrees of freedom of the System, and the low and random autocorrelations of non-systemic war dynamics, together make a powerfully compelling case for the hypothesis that the non-systemic war dynamics normally show(ed) chaotic characteristics. This implies that not only the finite-time singularity accompanied by four accelerating cycles is deterministic in nature, but also the System's war dynamics 'one level down' (at the level of cycles). The System is a rule-based deterministic system with only a few (but at least two) variables determining its non-systemic war dynamics. Because non-systemic wars are normally (except for the exceptional periods 1657-1763 and 1953-1989) chaotic in nature, they are – contrary to systemic wars making up the cycles of the finite-time singularity dynamic – intrinsically unpredictable, at least with respect to their intensity and size (and probably timing).

151 The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) ensured the fastest and most efficient development of the anarchistic System toward a next – and unavoidable – level of SIE.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Optimization, Dual-phase transition, Next level of SIE, First exceptional period, Inefficiencies.*

In part I and II, I discussed the highly optimized ('sub') dynamics (components) of the first finite-time singularity dynamic, that collectively contributed to the optimization of to the performance and evolvability of the anarchistic System.

Consistent with the demands of the second law of thermodynamics, the free energy the anarchistic System produced, was periodically put to work through (four) systemic wars. Through these systemic wars, the System upgraded its 'orders' - organizational arrangements that underpinned successive international orders - to allow for a lower energy states of the System. Because the anarchistic System produced free energy (tensions) at an accelerating rate (and in accelerating amounts), the four systemic wars were produced at an accelerating rate, and with accelerating amplitudes.

The moment (in 1939) the anarchistic System reached the critical connectivity threshold (the singularity in finite time) the anarchistic System produced infinite amounts of free energy (tensions), as a consequence collapsed and produced a dual-phase transition in response. Through the dual-phase transition (the fourth systemic war, the Second World War, 1939-1945), in order to meet the requirements of the second law of thermodynamics, the System simultaneously implemented two dedicated non-anarchistic hierarchies in Europe (the core of the System), and a first global order at a global scale of the System.

The successive upgraded orders that were implemented (in the deterministic domain of the System), implied that increasingly comprehensive organizational arrangements that underpinned successive international orders could – and had to be – implemented in the contingent domain of the system.

The increasing amounts of free energy (tensions) that was produced, and the application of the second law of thermodynamics, in combination with a number of other deterministic laws and mechanisms, resulted in a highly path dependent dynamic; the finite-time singularity dynamic locked in on increasingly 'more' order, by increasingly destructive systemic wars.

I argue that the finite-time singularity dynamic accompanied by four accelerating cycles was the fastest and most efficient path to the dual-phase transition, and thus to the next level of SIE; the singularity dynamic did not waste much time and energy to get there.

Only temporarily – during the first exceptional period (1657-1763) – were the optimal dynamics of the System disrupted. During the first exceptional period the non-systemic war dynamics of the System were temporarily not chaotic, but periodic in nature; the non-systemic wars became temporarily hyper-excited as a consequence of the lack of a third – balancing – degree of freedom.

As I explain in more detail in part II and in a number of other statements, the abnormal non-systemic war dynamics during the first exceptional period (during the second cycle) caused a delay in the unfolding of the finite-time singularity dynamic of about 13 years, and the System also produced significant larger amounts of free energy, that led to the deployment of excessive amounts of destructive energy, as I show in below table.

Differences between severities of wars: actual versus theoretical first finite-time singularity dynamic. (Severities in BCD of Great Powers, data based on Levy (38))

	International order			Systemic war			Cycle		
	Actual	Theo.	Delta	Actual	Theo.	Delta	Actual	Theo.	Delta
1	1,005,000	1,065,000	- 5.63	1,971,000	1,971,000	0.00	2,976,000	3,036,000	- 1.98
2	5,018,300	850,000	460.39	2,532,000	4,900,000	- 48.33	7,550,300	5,750,000	31.31
3	690,780	620,000	11.42	7,734,300	8,100,000	- 4.51	8,425,080	8,720,000	-3.38
4	55,000	400,000	- 86.25	12,948,300	11,100,000	16.65	13,003,300	11,500,000	13.07

Table 85 *In this table I give an overview of 'energy discrepancies' between the actual and theoretical first finite-time singularity dynamic that was accompanied by four cycles (1495-1945). The figures in this table concern the severities (in BCD, of Great Powers involved) of the sum of the severities of non-systemic wars during successive international orders, of systemic wars, and of cycles (total). I consider the severity of wars a measure for the free energy (tensions)*

that is produced in the System. In the column 'Delta' I show the deviation (in percent) from the theoretical model of the finite-time singularity dynamic. A number of deviations are significant: (1) the sum of the severities of non-systemic wars during the second international order is 'extreme'; a deviation I – as explained – attribute to the abnormal war dynamics during the first exceptional period (1657-1763), (2) the severity of the second systemic war is significant lower; an ('compensation') effect I also attribute to the abnormal war dynamics during the first exceptional period (1657-1763), (3) the sum of the severities of non-systemic wars during the fourth international order is significant lower than the theoretical model 'predicts'; an effect that can probably be attributed to finite-size effects, that impacted the non-systemic war dynamics of the System at that stage (shortly before its collapse), and (4) the severity of the fourth systemic war is significantly higher, an effect I attribute to the globalization effect.

152 Abnormal war dynamics during the first exceptional period (1657-1763) caused a delay of 13 years in the development of the second cycle (1648-1815) and in the unfolding of the finite-time singularity dynamic (1495-1945).

KEY WORDS *Abnormal war dynamics, Delay, First exceptional period.*

In this statement I quantify the delaying effect in the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), I assume was caused by the abnormal war dynamics during the first exceptional period (1657-1763). The (speculative) calculations related to the 'delay-effect' are based on the assumptions that (1) the frequency of successive cycles, as well as (2) the severities of successive systemic wars, should accelerate very regular.

I argue that abnormal conditions during the first exceptional period (1657-1763) caused a delay in the unfolding of the finite-time singularity dynamic (1495-1945). The abnormal conditions (a temporary decrease in the number of degrees of freedom in the System to two) during this period, caused the System to produce periodic (more extreme, unconstrained and but also more regular), instead of chaotic (more restrained and intrinsically unpredictable) non-systemic war dynamics.

In this statement I make a speculative calculation of the delay in the unfolding of the singularity dynamic the abnormal conditions caused.

However, another 'distortion' should also be addressed: I argue that the life span of the first cycle (1495-1648) also is not correct, and that this 'distortion' (a matter of 'measurement') must be taken into consideration to determine the delay that was caused by the abnormal conditions during the first exceptional period (1657-1763).

A visual inspection of the first wars in Levy's data set (see also various figures in part I) show that the sizes of the first non-systemic wars during the first relatively stable period (the first international order) were relatively large compared to the typical size of non-systemic wars during the early stages of development of the other three relatively stable periods (that followed systemic wars). I argue that Levy's dataset is incomplete, and that a number of non-systemic wars should have been included in the dataset. This implies that the System actually 'started' at an earlier stage than Levy (and other historians) propose.

Consistent with the theoretical model of the singularity dynamic, I suggest that six non-systemic wars should be included in the dataset, bringing the start date of the first cycle and the System itself forward. My speculative reasoning is as follows. Assuming that the absolute numbers of non-systemic wars during the second and third cycle are more or less accurate, it can be reasoned that the number of non-systemic wars during the first cycle should be 51 instead of 45 (as Levy's dataset suggests); by adding six wars the linear decrease in the absolute number of non-systemic wars during successive relatively stable periods is 'complete'.

During successive cycles, non-systemic wars have average return-times, which specify the average amount of time that elapses during a relatively stable period between the start of two successive non-systemic wars. During the first cycle, the return time was 2.7 years. Based on this reasoning, I assume that six missing non-systemic wars took place over a period of 16.2 years. This implies that the first cycle of the singularity dynamic, and the System itself, started around 1480 and not around 1495. According to Overy, during the period between 1480–1495, the System experienced five non-systemic wars with Great Power participation (45). It seems that these particular wars should be included in the dataset. If they are added, the size-development of non-systemic wars in the early stages of the first relatively stable period becomes more regular.

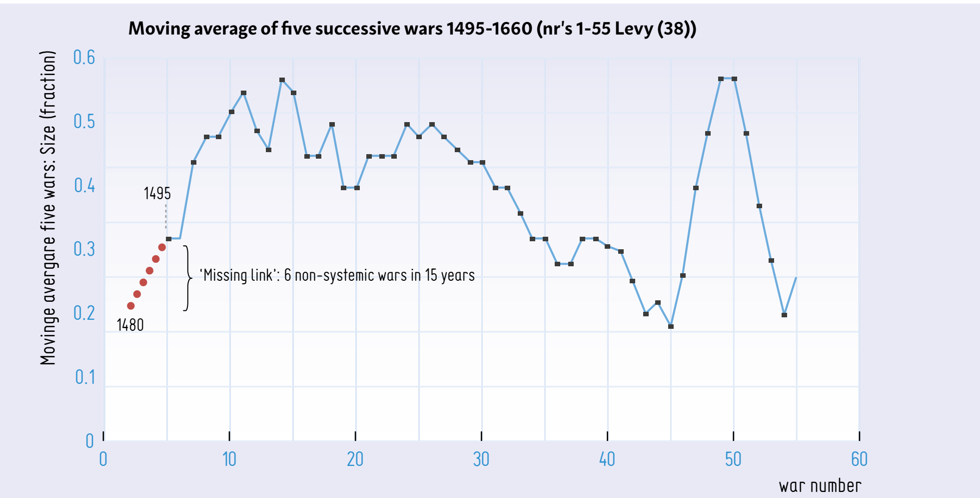


Figure 93 *In this figure the moving average of five successive wars is shown during the period 1495-1650 (war nr's Levy 1-55 (38)). I have complemented the data with six non-systemic wars (in red): the dynamics suggest these wars are missing in the data. Given the average*

return time of non-systemic wars during the first relatively stable period (1495-1618), this implies the System started around 1480, and not in 1495. If six wars are added to the total number of non-systemic wars during the first relatively stable period (45 plus 6 is 51), the singularity dynamic is more consistent (see consistency index).

The corrected lifespan of the first cycle makes it possible to better determine the necessary correction for the life span of the second cycle (1648-1815, that includes the first exceptional period (1657-1763), which is required for deriving the theoretical – undistorted – model of the first finite-time singularity dynamic accompanied by four accelerating cycles.

Correction of lifespans of cycles (and relatively stable periods)			
	Uncorrected life span	Applied correction	Corrected life span
1	153	Plus 15	168
2	167	Minus 13	154
3	103	NA	NA
4	27	NA	NA

Table 86 *This table shows the corrections that are applied to the life spans of cycles (relatively stable periods)*

If the acceleration rate of successive cycles of the System is applied, and when the adjusted life span of the first cycle (168 years, 1480-1648) is taken into account, the life span of the second cycle should be 154 years, 13 years shorter.

I have determined the corrected lifespan through finite-tuning the properties – including the acceleration rate of life spans – of the theoretical finite-time singularity dynamic; a method I describe in part II and a number of statements in part III.

I attribute this delay to the abnormal conditions during the first exceptional period (1657-1763) and their impact on the nature of the non-systemic war dynamics of the System. Assuming that all other conditions were unchanged, this delay also implies that the System would have experienced the second, third, and fourth systemic war also about 13 years before their actual dates.

9 NON-CHAOTIC NON-SYSTEMIC WAR DYNAMICS AND EXCEPTIONAL PERIODS

153 The number of other states decision makers of states take into account regarding war decisions, determines the number of degrees of freedom of the System, and the nature of its war dynamics.

KEY WORDS *Exceptional periods, Chaotic war dynamics, Non-chaotic war dynamics, Degrees of freedom, Periodic war dynamics, Resumption of chaotic war dynamics.*

I argue that two exceptional periods can be identified in the war dynamics of the System during the period 1495-2016; a first exceptional period (1657-1763) during the life span of the second international order (second relatively stable period, 1648-1792) of the first finite-time singularity dynamic, accompanied by four cycles (1495-1945), and a second exceptional period (1953-1989), better known as the 'Cold War', during the life span of the fifth international order, the first relatively stable period (1953-...) of the second singularity dynamic, accompanied by probably three accelerating cycles (1945-2156).

I attribute the abnormal non-systemic war dynamics during these two exceptional periods to respectively the intense rivalry between Britain and France, and between the United States and the Soviet Union. I assume that as a consequence of these intense rivalries, the number of degrees of freedom (n) of the System was temporarily reduced to two: During these periods all issue in the System were one way or the other connected to – dominated by – these rivalries. Concerning their war decisions states only took two other states into consideration.

Typically, chaotic dynamics require at least three degrees of freedom ($n > 2$); two degrees of freedom produce periodic dynamics. Both types of dynamics are 'related' in the sense that they are separated by only one degree of freedom.

During the first exceptional period (1657-1763), wars were either relatively small with a low intensity, or extremely large with a high intensity. In phase state the rivalry between Great Britain and France resulted in simple zigzag trajectories instead of circular ones, as figure 3 shows. These more extreme periodic all-or-nothing war dynamics (in terms of size and intensity) when the System was governed by only two degrees of freedom, can intuitively be explained by the fact that, under those conditions ($n = 2$), the System and its dynamics lacked a third degree of freedom that acted as a balancer in war decisions of states and in resulting dynamics.

If $n > 2$, implying that a third state is considered in war decisions, war dynamics are chaotic in nature and more restrained; a third state (that is considered in war decisions) has in other words an inhibitory effect on war decisions and resulting war dynamics.

The rivalry between these Great Powers was eventually settled in favor of Great Britain in 1763 (through the Seven Years' War). After this war, typical circular, chaotic trajectories resumed. These changes in dynamics from chaotic to periodic in 1657 and vice versa in 1763, can be defined as 'bifurcations.' In statement 168 I discuss two 'identical' subcycles that can be identified in the war dynamics, during the first exceptional period.

During the second exceptional period (1953-1989), the eight non-systemic wars the System produced were very subdued, and (for one exception) took place outside of Europe; outside of the main 'focus' of the rivalry between the United States and the Soviet Union.

As the resumption of the typical circular trajectories in phase state show, the System resumed chaotic war dynamics in 1989.

154 The processes of integration in Europe and the further globalization of the System were temporarily delayed (1953-1989) as a consequence of the intense rivalry between the United States and the Soviet Union, and resumed when eventually the Eastern hierarchy collapsed (1989).

KEY WORDS *Integration, Globalization, Second exceptional period, Deadlock, Collapse Eastern hierarchy, Chaotic war dynamics.*

The implementation of two dedicated non-anarchistic hierarchies in Europe – the Western and Eastern Hierarchies, respectively dominated by the United States and the Soviet Union – was indicative of the rivalry between the United States and the Soviet Union, following the fourth systemic war (the Second World War, 1939-1945). As a consequence of this rivalry the implementation of a unified hierarchy was not achievable. I make the assumption that the connectivity in Europe allowed for such a solution at an earlier stage (1945), as the absorption of Eastern states into the Western hierarchy after the collapse of the Eastern hierarchy in 1989 suggests.

Following the Second World War (the fourth systemic war, 1939-1945), and the dual-phase transition it resulted in, Europe, as an extension of the global reach of both superpowers (the United States and the Soviet Union), became the central source of free energy (tension) production in the global System. The intense rivalry between both superpowers and the hierarchies they controlled produced a new exceptional period (1953-1989) governed by only two degrees of freedom that defined its non-systemic – abnormal – war dynamics.

Whereas during the first exceptional period (1657-1763), intense rivalry led to a series of highly predictable and severe non-systemic wars – hyper-excited war dynamics – during the second exceptional period (1953-1989) the System produced highly subdued non-systemic war dynamics.

Possession of highly destructive nuclear weapons with global reach that assured mutual destruction of both superpowers and their allies, and the ability of both superpowers to maintain a credible second strike capability, made the basic security requirements of the United States and the Soviet Union and their respective allies inseparably connected.

The global power projection capabilities and influence of both superpowers connected all global issues and tension to the main issue, Europe, and as a consequence of the high-connectivity of issues and tensions, non-systemic wars could only sporadically be produced and could only take place outside Europe; most non-systemic wars did not – and could not – directly involve the main rivals.

This dynamic changed dramatically when, in 1989 the Eastern Hierarchy collapsed as a consequence of their internal imbalances. A lack of internal adaptability of their systems, in combination with the high demands made by their rivalry with the Western Hierarchy and the United States contributed to these collapses.

These combined collapses had a number of consequences:

1) It led to the absorption of Eastern European states into the Western Hierarchy via the European Union.
2) It caused a resumption of chaotic non-systemic war dynamics, which were no longer suppressed by the intense rivalry between the United States and the Soviet Union.
3) It led to an initial disengagement of both superpowers from European affairs.
4) It led to a shift in centers of tension in the System.
5) It led to the collapse of states that were artificially kept alive as a part of the rivalry between the United States and the Soviet Union through their efforts to maximize their influences in the global System. A lack of support meant that certain states could not adequately fulfill their basic requirements; they lost internal balance and collapsed. Often these failed states were only artificial constructs imposed on territories by European states, and were not the outcome of a necessarily long-term process of internal and external tuning and fine-tuning to adequately organize them for the balanced fulfillment of basic requirements.

The collapse of the Soviet Union redefined the global System and its dynamics, and caused a number of global shifts. Until 1989, the rivalry between Great Powers was still strongly focused in (and on) Europe, the global crystallization point of tensions between the two superpowers of the global System.

The collapse of the Soviet Union allowed for completion of the temporarily delayed process of social integration in Europe (1953-1945), a shift in the centers of tensions, and the unleashing of chaotic war dynamics on the global anarchistic System.

155 A number of developments contribute to the level of tensions – free energy – in the current System.

KEY WORDS *second law of thermodynamics, Deterministic laws, Contingent domain, Security dilemma, Interacting self-fulfilling prophecies, Developments, Production free energy, Crystallization.*

The properties of energy releases – when, where, their sizes, and frequencies – are determined and shaped by the second law of thermodynamics, and by other deterministic laws and principles that apply to the dynamics and development of the System. These deterministic principles include the number of degrees of freedom that determine the nature of the System's non-systemic ward dynamics, and the connectivity/local stability effect that comes into effect when the System reaches the tipping point during relatively stable periods.

In the contingent domain, other factors are also at play, as long as they do not conflict with the deterministic laws and principles. These contingent principles include the security dilemma and interacting self-fulfilling prophecies between states, that for example 'determine' how and where tensions crystallize in underlying vulnerable issue clusters, that will eventually be activated.

The high susceptibility of the System during criticality makes it impossible to determine in advance what specific incident or event will trigger a systemic war, or how tensions and war activities will shape the systemic war that is produced.

Current (2016) developments in the System make it possible to identify 'drivers' that contribute to the production and crystallization of issues and tensions in the System:

1) Rivalries between Great Powers: The United States, China, Russia and France and Britain; and between Great Powers and other states;
2) Local issues with potential global impacts because of (in)direct involvement of Great Powers. These local issues include issues in the Middle East, Eastern Europe, the South China Sea, and in Europe itself.
3) Radical religious communities that leverage the interconnected network – the Internet – to mobilize and deploy destructive energy at a global scale, in efforts to undermine the legitimacy of states and the current international order;
4) The differentiated growth of Great Powers, and other states;
5) The (increasing) obsolescence of current orders (the United Nations, and the European Union).

Eventually, these – and probably other – vulnerable issue clusters will percolate the global system, cause criticality and produce a systemic war. Achieving criticality and systemic war is consistent with the second law of thermodynamics, and ensures that free energy is put to work to implement upgraded orders that allow for a lower free energy state of the System.

156 The intense rivalry between the United States and the Soviet Union following the fourth systemic war (the Second World War, 1939-1945) produced a second exceptional period (1953-1989).

KEY WORDS *Rivalry, Second exceptional period, Degrees of freedom, Highly subdued war dynamics, 1989.*

During the second relatively stable period (international order, 1648-1792) of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the intense rivalry between Britain and France caused a temporary reduction in the degrees of freedom (n) in the System; as a consequence of the intense rivalry, the degrees of freedom in the System were reduced from n > 2 to two (n = 2), and the System produced periodic instead of chaotic non-systemic war dynamics. These abnormal non-chaotic non-systemic war dynamics occurred during the period 1657-1763. This period I designate as the first exceptional period.

The fourth systemic war (the Second World War, 1939-1945) constituted a dual-phase transition; the ultimate 'step' of the finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period.

The dual-phase transition resulted in the simultaneous implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a first global international order at a global scale of the System.

The two dedicated non-anarchistic hierarchies that were implemented in Europe, were controlled by the United States (the Western hierarchy) and the Soviet Union (the Eastern hierarchy) respectively.

Following the dual-phase transition (1939-1945), the rivalry between the United States and the Soviet Union, and the respective hierarchies they controlled intensified, and resulted in a second exceptional period (1953-1989). During the second exceptional period – better known as the Cold War – interactions and relationships in the global System, became increasingly dominated by the intensifying global rivalry between the United States and the Soviet Union.

Contrary to the non-chaotic war dynamics during the first exceptional period (1657-1763), the non-systemic and non-chaotic war dynamics during the second exceptional period (1953-1989), were not hyper-excited and periodic in nature, but highly subdued instead. Only for one exception (the Sinai war, 1956, nr. 117)), only one Great Power participated in the eight non-systemic wars the System produced during the second exceptional period; except for one of these wars, (the Russo-Hungarian War, 1956, nr. 116) these wars occurred outside of Europe.

These highly subdued non-systemic war dynamics can be explained by the very high connectivity of the network of issues and states in the System; all issues in the System during the second exceptional period (1953-1989), were one way or the other, related to the intense (world-wide) rivalry between the United States and the Soviet Union. During the second exceptional period (1953-1989), the condition of the System – and network of underlying vulnerable issue clusters – resembled the condition of the System during a high-connectivity regime, shortly before becoming critical and producing a systemic war. The high connectivity of states in the System, produced this exceptional 'stable' and relatively long condition.

The System could maintain itself in this 'stable' almost critical condition, because of the potentially self-destructive deadlock both rival states had created. The intense rivalry between both Powers had resulted in the (preventive) deployment of large amounts of highly destructive weapon systems. The destructiveness and range of these (nuclear) weapon systems on the one hand, and level of protection (invulnerability) of components of these weapons systems on the other hand, resulted in strategies that assured 'mutual assured destruction' (MAD in nuclear strategy terminology).

The United States and the Soviet Union had assured that their nuclear capabilities could not be (completely) destroyed by a first strike by their rival, and that they under all circumstances maintained a second strike capability that allowed for the destruction of the other state (even after a first strike of their adversary). Under those 'MAD-conditions' war as an instrument of policy/politics – to ensure the survival of states and their populations – had become obsolete. This particular condition – the second exceptional period – ended when the Eastern hierarchy collapsed in 1989.

The moment the Eastern hierarchy collapsed (1989), the intense rivalry between the United States and the Soviet Union was 'resolved' (at least temporarily) and the System could resume chaotic non-systemic war dynamics. Initially Russia – the core-state of the Soviet Union – was preoccupied by its internal dynamics related to the collapse of the Soviet Union and Eastern hierarchy; but at a later stage – in the early 21st Century – when Russia had recovered from the process of fragmentation, it resumed typical Great Power behavior in the System.

157 During the first exceptional period (1657-1763) the non-systemic war dynamics of the System were periodic in nature, and became hyper-excited; during the second exceptional period (1953-1989) the non-systemic war dynamics of the System were very subdued.

Key words: Exceptional periods, Non-systemic war dynamics, Hyper-excited war dynamics, Subdued war dynamics, Rivalry, Degrees of freedom, MAD.

During the second relatively stable period (1648-1792) of the finite-time singularity dynamic (1495-1945), the non-systemic war dynamics of the System were temporarily distorted, and were periodic instead of chaotic in nature. This temporary change in the nature of the non-systemic war dynamics of the System can be attributed to a change in the number of degrees of freedom of the System. The number of other states decision makers of states take into consideration regarding war decisions, determines the number of degrees of freedom of the System.

Normally, the number of degrees of freedom of the System is at least three (n > 2). In case n > 2, the System produces chaotic non-systemic war dynamics (intrinsically unpredictable, sensitive for initial conditions, circular trajectories in phase state, etc.). During the first exceptional period (1657-1763), however, the number of degrees of freedom was temporarily reduced to only two; as a consequence of the intense rivalry between Britain and France, I argue. In case n = 2, the System produces non-chaotic non-systemic war dynamics, that were during the first exceptional period in nature.

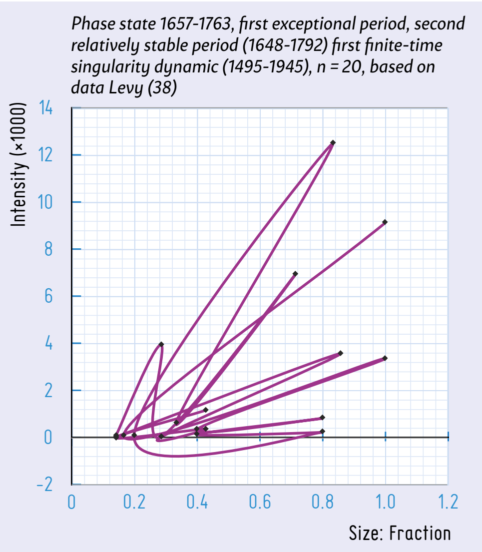


Figure 94
In this figure phase state is shown during the first exceptional period (1657-1763), second cycle, first finite-time singularity dynamic (1495-1945).

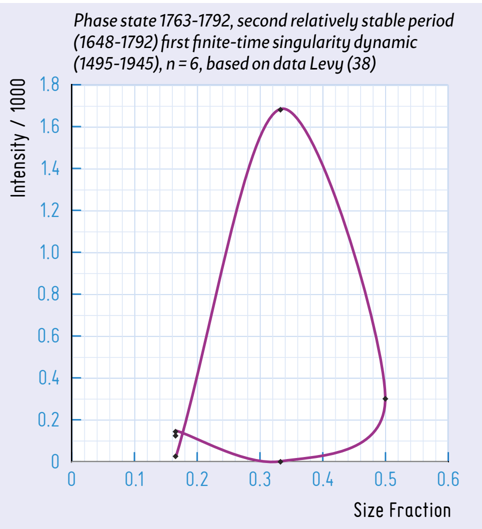


Figure 95
In this figure phase state is shown during the period 1763-1792, after the System resumed chaotic war dynamics (second cycle, first finite-time singularity dynamic (1495-1945)).

Analysis shows, that a second exceptional period (1953-1989) can be observed during the first relatively stable period (1945-...) of the second singularity dynamic (1945-...). I argue that the abnormal war dynamics during the second exceptional period can be attributed to the intense rivalry between the United States and the Soviet Union during that period of time (1953-1989, better known as the Cold War). However, instead of becoming hyper-excited (as was the case during the first exceptional period), non-systemic war dynamics during the second exceptional period, were highly subdued.

In both cases, when the intense rivalries were settled that were responsible for the temporary decreases in the number of degrees of freedom, the System resumed chaotic non-systemic war dynamics (respectively in 1763 and 1989).

Figure 96
In this figure phase state is shown during the second exceptional period (1953-1989), first cycle, second finite-time singularity dynamic (1945-...).

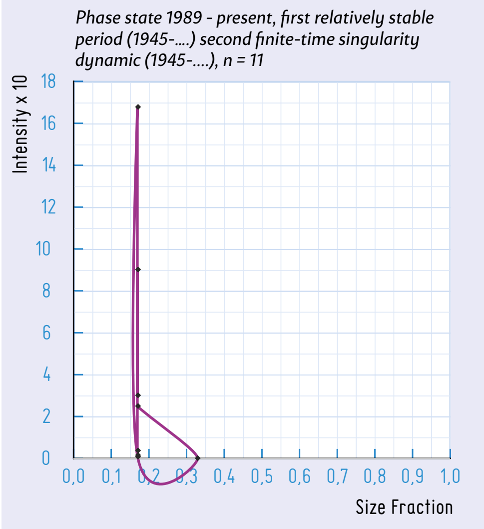
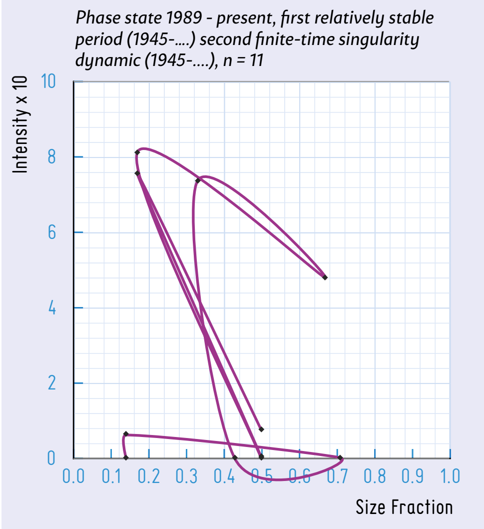


Figure 97
In this figure phase state is shown during the period 1989-present, after the System resumed chaotic war dynamics (first cycle, second finite-time singularity dynamic (1945-...)).



An interesting question is, why, despite a number of similarities between both exceptional periods, in the first case non-systemic war dynamics became hyper-excited, and in the second case highly subdued.

Before I further elaborate on this issue, I also mention another similarity between both cases: In both cases – in case of the first and second exceptional period – the System was in a low-connectivity regime. The relatively stable period the first exceptional period (1657-1763) was situated in, reached its tipping point in 1774; the relatively stable period the second exceptional period was situated in, reached its tipping point in 2011.

I assume that a decrease in the number of degrees of freedom (n = 2) during low connectivity regimes, causes the issue network to become 'over-connected': all issues become 'one way or the other' connected to the intense rivalry between just two Great Powers.

The behaviors of the System during the first and second exceptional period suggest that the System can respond in two ways to such an over-connected condition; non-systemic war dynamics can become either hyper-excited or highly subdued.

In case of a hyper-excited response, large amounts of free energy (tensions) are produced, and as a consequence of a lack of 'inhibition' (a third degree of freedom) more or less immediately released. These non-systemic release events (assuming that they do not bring an end to the intense rivalry) than further contribute to the rivalry between both states, and provoke even more extreme reactions. This was the logic of the abnormal war dynamics during the first exceptional period.

Although there were numerous similarities between both exceptional periods, the large amounts of free energy (tensions) that were produced during the second exceptional period (1953-1989), could not be released (as was the case during the first exceptional period). The intense rivalry between the United States and the Soviet Union, had resulted in a deadlock; both superpowers had preventively deployed large amounts of destructive energy (nuclear weapons) to intimidate their respective adversary, but also had ensured that they could under all circumstances – also in case of a 'first nuclear strike' by the adversary – launch a (second) nuclear strike in response. The 'second strike capabilities' of both superpowers ensured 'mutual assured destruction' (MAD). MAD made that war no longer was "mere a continuation of policy/politics by other means"; War had become a guarantee for (mutual) self-destruction.

Dominance over Europe (the erstwhile core of the anarchistic System (1495-1945)) was at stake in this rivalry. The eight non-systemic wars the System produced during the second exceptional period (1953-1989) were for above mentioned reasons small in size, and took in all cases (except for the Sinai War, 1956, nr 117) place outside of Europe. The trajectories in phase state confirm their abnormality.

158 The number of degrees of freedom of the System, determines the anarchistic System's 'internal restraint/inhibition'; internal restraint is required for the System's development.

KEY WORDS *Degrees of freedom, Exceptional period, Non-systemic war dynamics, Chaos, Restraint, Development.*

When n = 2, the System lacks built-in inhibition and war activity is easily amplified; non-systemic wars can even span the entire System, despite the fact that the System is not critical. The System becomes in other words 'hyper-excited', leading to extreme dynamics; as was the case during the first exceptional period. (It is interesting to note that a similar dynamic can be observed in brain activity; both the brain and the System can be considered a complex network). I quote Beggs et al.: "… by blocking inhibitory synaptic transmission (*IP: equivalent with a temporary reduction of the degrees of freedom of the System to two*), it is possible to make the tissue (*IP: equivalent with the System*) hyper exited, leading to larger avalanches (*IP: equivalent with non-systemic wars*) (10). This looks like the supercritical phase, where activity is often amplified until it spans the entire system.")

In case of a third degree of freedom (variable, a third state that must be considered in war decisions), the System is better balanced, and its dynamics are more restrained. In case of a third degree of freedom non-systemic war dynamics are chaotic in nature: chaotic war dynamics and restraint go hand in hand in the anarchistic System.

I argue that because of the n = 2 conditions of the System during the first exceptional period, resulting in hyper-excited non-systemic war dynamics, the System could not reach the tipping point (and the high-connectivity regime) of the relatively stable period. Development of the System – unfolding of the singularity dynamic – requires restraint:

The System must experience a high connectivity regime and chaotic conditions (n > 2) that allow for a steady buildup of tensions in the System, and the crystallization of vulnerable issue clusters with fractal structures, that eventually percolate the System, and cause it to become critical and produce a systemic war. A high connectivity regime and chaotic conditions are necessary to prepare and 'charge' the System to produce a systemic war.

When the System in 1763 resumed its chaotic war dynamics, it also very quickly resumed its path toward criticality, ensuring the unfolding of the singularity dynamic. (See also: (67))

159 Abnormal non-systemic war dynamics during the first exceptional period (1657-1763) disrupted the otherwise smooth unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), causing a delay and inefficiencies in its development.

KEY WORDS *Degrees of freedom, Chaotic war dynamics, Singularity dynamic, Exceptional period, Delay, Inefficiencies.*

During the first exceptional period (1657-1763) the anarchistic System lacked a third degree of freedom, and as a consequence an internal control mechanism that restrained its war dynamics. The abnormal periodic non-systemic war dynamics the System produced during the first exceptional period (1657-1763), were often exceptionally sever and in some cases system-wide (in size).

The abnormal and extreme non-systemic war dynamics during the first exceptional period prevented the second relatively stable period (1648-1792) from reaching its tipping point and high-connectivity regime. A high-connectivity regime during a relatively stable period, is a necessary condition for the System to be able to store free energy (tensions) and grow (crystallize) underlying vulnerable issue clusters with fractal structures that will eventually percolate the System, cause it to become critical and produce a systemic war. Through systemic wars the System implements upgraded orders that allow for lower energy states, and next levels of integration in the contingent domain of the System. Hyper-excited war dynamics during the first exceptional period, resulted in the (more or less) immediate release of free energy (tensions) that built up in the System, while 'storage' was not possible (or necessary); as a consequence, the System could not sufficiently 'charge' itself for a massive energy release, necessary for a next systemic war to be produced.

In two respects the abnormal non-systemic war dynamics during the first exceptional period (1657-1763) caused inefficiencies in the further development and unfolding of the finite-time singularity dynamic: (1) the abnormal war dynamics caused a delay of about 13 years, in the singularity's unfolding, as I calculated, and (2) inefficiencies in the production and release of free energy (tensions). Calculations suggest that during the second cycle (the second relatively stable period (1648-1792) and the systemic war that followed (the second systemic war, the French Revolutionary and Napoleonic Wars, 1792-1815) the System produced too high levels of free energy; calculations suggest that the energy-inefficiency of the second cycle was about plus 31 percent (see table 85).

160 Abnormal war dynamics during the first exceptional period (1657-1763) caused a delay and inefficiencies in the development and unfolding of the finite-time singularity dynamic (1495-1945).

KEY WORDS *Singularity dynamic, Exceptional period, Degrees of freedom, Chaotic non-systemic war dynamics, Periodic non-systemic war dynamics, Delay, Energy-inefficiencies.*

The intense rivalry between Britain and France during the period 1657-1763 (designated the 'first exceptional period'), resulted in a temporary reduction in the degrees of freedom (n) of the System to two; as a consequence, the non-systemic war dynamics of the System became periodic. Normally, the number of degrees of freedom of the System is at least three, and non-systemic war dynamics are chaotic in nature.

These abnormal (that is non-chaotic) war dynamics had two effects, I argue: (1) a lengthening of the lifespan of the second relatively stable period (second international order, 1648-1792)), which delayed the emergence of the next systemic war and the unfolding of the singularity dynamic, and (2) the emergence of a series of exceptionally large non-systemic wars with exceptional high intensities. These effects can be explained as follows:

1 ***Temporary 'postponement' of the second systemic war***

During the 1495-1945 period a finite-time singularity dynamic accompanied by four accelerating cycles determined and shaped the dynamics and development of the anarchistic System. Each cycle consisted of a relatively stable period (international order), followed by a critical period (systemic war). During relatively stable periods it is possible to distinguish two 'regimes'; respectively a low- and high-connectivity regime, divided by a tipping point.

This study shows that chaotic non-systemic war dynamics during high-connectivity regimes are a precondition for the anarchistic System to become critical and produce systemic wars: The System needs to be 'charged'.

During critical periods, free energy (tensions) that has accumulated in the System, is put to work to implement upgraded orders that allow for lower energy states of the System, consistent with the requirements of the second law of thermodynamics. Critical periods/systemic wars, are in other words instrumental in the development of the System to ever-higher levels of order.

Chaotic non-systemic war dynamics are a precondition for the System to become critical, because chaotic war dynamics, contrary to periodic war dynamics (1657-1763), are 'intrinsically' more inhibited, and their inhibition contributes to the charging of the System.

The 'inhibition' of chaotic non-systemic wars is a consequence of the impact of a third (or fourth) degree of freedom. A third degree of freedom has in other words a balancing effect. In case the System has three degrees of freedom, states are more reluctant to engage in war because of the greater unpredictability of the System under those particular (chaotic) conditions.

Unpredictability is a synonym for risk and thus for restraint. During the first exceptional period (1657-1763), the number of degrees of freedom of the System was temporarily reduced to two as a consequence of the intense rivalry between Britain and France; tensions levels in the System were very high, while the System as such was transparent ('simple'; all issues were dominated by the intense rivalry between Britain and France), easier to understand, and more predictable; therefore, hedging of risks was not considered necessary (or possible). As a consequence of these 'simplified' conditions, issues became over-connected and the System became hyper-excited, resulting in more extreme non-systemic wars, in size as well as intensities.

High-connectivity regimes are a precondition for the System to become critical, because the connectivity/local stability effect that manifest itself during high-connectivity regimes increasingly 'inhibits' non-systemic war dynamics (non-systemic energy releases). Instead of being released during a high-connectivity regime, free energy (issues and tensions) is 'stored' in the System, forms a free energy release deficit, and crystalizes into vulnerable issue clusters with fractal structures. The moment these vulnerable issue clusters percolate the System, the System becomes critical and produces a systemic war.

Both the intrinsic inhibition of chaotic non-systemic war dynamics and of high-connectivity regimes, are necessary to charge the System for systemic wars.

Because during the first exceptional period (1657-1763) non-systemic wars were non-chaotic in nature, the System could not reach the high-connectivity regime and charge itself for the next systemic war. The intense rivalry between Britain and France, caused a delay in the (otherwise) smooth development and unfolding of the finite-time singularity dynamic. The moment in 1763 the intense rivalry between Britain and France was resolved, the System resumed chaotic non-systemic war dynamics, reached the tipping point in 1774, and produced a next systemic war in 1792 (the second systemic war, the French Revolutionary and Napoleonic Wars, 1792-1815).

I determined that the delay the abnormal war dynamics during the first exceptional period caused is about 13years.

2 *Energy-inefficiencies: 'Overproduction' of free energy and 'over-deployment' of destructive energy*

The second effect of abnormal non-systemic war dynamics during the first exceptional period (1657-1763) concerns 'energy-inefficiencies'. I consider the severities of wars indicative for the destructive energy that is deployed during wars, and for the free energy that had built up in the System. Analysis suggests that energy production during cycles, that is during successive relatively stable periods and systemic wars that followed these relatively stable periods, developed very regularly. However, this analysis also suggests that the System during the second cycle (1648-1815, that includes the first exceptional period, 1657-1763), produced significantly more severe wars. It seems that during the second cycle, more destructive power was deployed, than a smooth development and unfolding of the finite-time singularity dynamic would have allowed, and that the energy-balance between the second relatively stable period and the second systemic war was disturbed.

These energy-inefficiencies I attribute to the abnormal non-systemic war dynamics during the first exceptional period: the lack of a third degree of freedom deprived the System of 'inhibition', and instead of producing chaotic non-systemic war dynamics, the System produced more extreme – hyper-excited – periodic non-systemic war dynamics.

I determined that the energy-inefficiency is about 31 percent ('over-production')

In this statement I discussed the effects of abnormal non-systemic war dynamics during the first exceptional period (1657-1763) on the development and unfolding of the first finite-time singularity accompanied by four accelerating cycles the System produced.

Following the dual-phase transition (through the fourth systemic war, the Second World War, 1939-1945), the System produced a second finite-time singularity dynamic, that still is developing and unfolding; presently the System is in the high-connectivity regime, of the relatively stable period of the first cycle (see also part IV).

As I also explained, this cycle also experienced abnormal war dynamics, during the period 1953-1989 (the second exceptional period). Contrary to the abnormal non-systemic war dynamics during the first exceptional period, these dynamics were not periodic in nature, but highly subdued. At this stage it is not possible to assess the impact of these dynamics, if there is any impact at all.

161 Abnormal non-systemic war dynamics during the first exceptional period (1657-1763) caused a postponement in the second systemic war, an overproduction in free energy (tensions) and distortions in the release distribution of the second cycle.

KEY WORDS *Abnormal war dynamics, Exceptional period, Delay, Inefficiencies, Overproduction, release ratio.*

In this statement I quantify the delay in the unfolding of the finite-time singularity dynamic (1495-1945) and the energy-inefficiencies the abnormal non-systemic war dynamics during the first exceptional period (1657-1763) produced (an 'overproduction' of free energy, and a distortion in the release ratio).

The (speculative) calculations of these effects are based on a model of an 'undistorted' version of the first finite-time singularity dynamic accompanied by four accelerating cycles, I constructed in part II.

The model of the first finite-time singularity dynamic is based on the assumptions that acceleration of the frequency of successive cycles, as well as the deployment of destructive energy during successive cycles, developed in a completely regular manner.

With this model it is possible to speculatively calculate the delay and energy-inefficiencies caused by the abnormal non-systemic war dynamics during the first exceptional period, by simply comparing respective properties with the actual 'performance' of the System.

1 ***Abnormal non-systemic war dynamics during the first exceptional period (1657-1763) caused a delay of 13 years in the unfolding of the singularity dynamic***
In part II I explained that not only the life span of the second cycle (1648-1815) needs to be corrected, but also the life span of the first relatively stable period (1495-1618) of the first cycle (1495-1648). This correction is necessary because – I argue – the inception date of the System was not 1495 (as for example Levy assumed (38)), but 1480, as can be derived from the war dynamics of the first relatively stable period. If this correction is applied, and acceleration is assumed to be more or less constant during the unfolding of the singularity dynamic, the life span of the second relatively stable period should be corrected downward with 13 years.

2 ***Abnormal non-systemic war dynamics during the first exceptional period (1657-1763) caused an 'overproduction' of 31 percent of free energy***
I refer to table 85. I consider severity of wars a measure for the free energy (tensions) that is produced. I attribute the overproduction of tensions to the lack of a third ('balancing') degree of freedom in the System during the first exceptional period.

3 ***Abnormal non-systemic war dynamics during the first exceptional period (1657-1763) caused a 'shift' in the release ratio of the second cycle of 51 percent.***
See below figures.

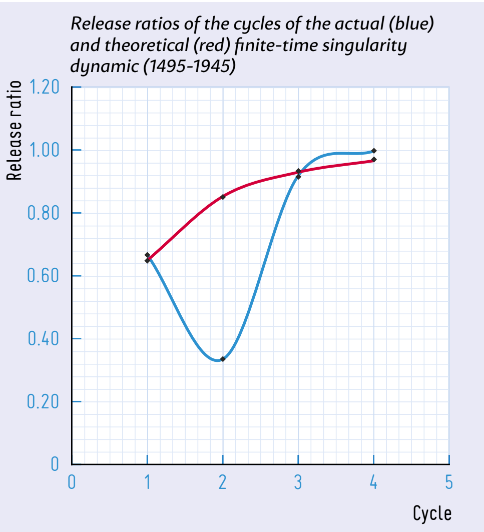


Figure 98
This table shows the release ratios of the successive cycles of the actual (in blue) and theoretical (in red) finite-time singularity that was accompanied by four accelerating cycles (1495-1945). The distortion caused by the first exceptional period is clearly visible (1657-1763).

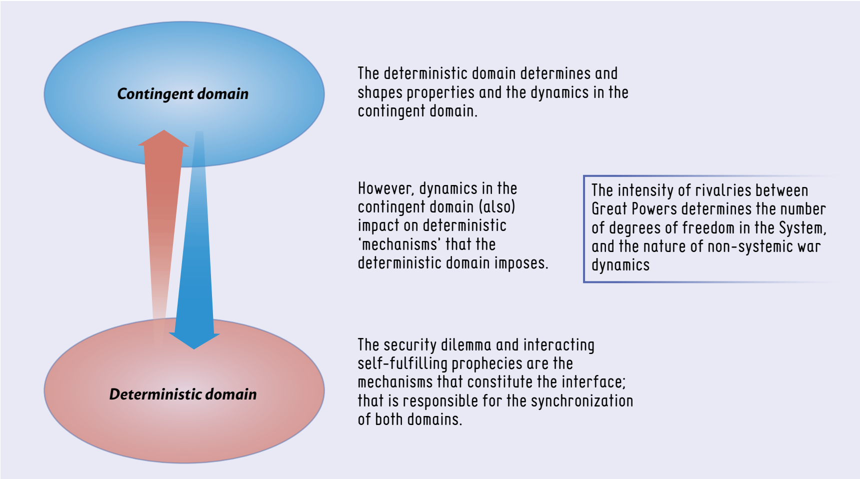


Figure 99 *In this figure the theoretical and actual release ratios are shown of the four accelerating cycles of the first finite-time singularity dynamic (1495-1945). This figure shows that ultimately (about) 100 percent of the free energy (tensions) was released through the fourth systemic war (the Second World War, 1939-1945). This effect can be attributed to the increasing robustness of successive relatively stable periods (international orders), as explained in this study. The distortion (51 percent) during the second cycle (1648-1815) is also clearly visible; this distortion I attribute to the abnormal (non-chaotic) non-systemic war dynamics during the first exceptional period (1657-1763).*

162 As a consequence of abnormal non-chaotic war dynamics during the first exceptional period (1657-1763) the 'energy-balance' between systemic and non-systemic wars (energy releases) during the second cycle (1648-1815) was distorted.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Intrinsic incompatibility, Delay. Energy-inefficiencies, Redistribution.*

(Increasing) connectivity and security are intrinsically incompatible in anarchistic systems and results in the production of free energy (tensions in the contingent domain of the System). Population growth and rivalries between states result in an increase of respectively the connectivity of the 'overall' System (network), and the issue-network in the System. Because of the growth rate of populations of states, free energy was (and still is) produced at an accelerating rate.

The second law of thermodynamics applies to the free energy that is created by the anarchistic System, and application of this law, in combination with a number of other deterministic laws and mechanisms, resulted in a finite-time singularity dynamic, accompanied by four accelerating cycles (1495-1945).

The moment the anarchistic System in 1939 reached the critical connectivity threshold, the System produced infinite amounts of free energy (tensions), and collapsed as consequence. The System's collapse was followed by a dual-phase transition (1939-1945, the fourth systemic war, the Second World War), that led to the simultaneous implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and the first global order at a global scale of the System.

This study shows that – true to its deterministic nature – the singularity dynamic, developed very regularly.

I argue that abnormal non-systemic war dynamics during the first exceptional period (1657-1763) caused a delay in the development and unfolding of the second relatively stable period (1648-1792) of about 13 years, and resulted in 'energy-inefficiencies'. With energy-inefficiencies I refer to the observation that during the second cycle (1648-1815), significantly more destructive energy was deployed, than would have been the case if the growth rate of destructive energy deployment during the first, third and fourth cycles was maintained. The energy-inefficiency of the second cycles was about 31 percent (overproduction), see also table 85

Another energy-inefficiency that can be observed, concerns the distribution of energy releases during the second cycle; between releases during the second relatively stable period and the second systemic war. The severity of the second systemic war (1792-1815, the French Revolutionary and Napoleonic Wars), in fact was lower than 'expected', while the total energy release – the 'total' of the severities of non-systemic wars during the second relatively stable period – was significantly higher. The abnormal non-chaotic non-systemic war dynamics during the first exceptional period (1657-1763) not only caused exceptionally high tension levels and large deployments of destructive energy through non-systemic wars (during the second relatively stable period), but also caused a shift in the distribution ratio of destructive energy during the second cycle (see figure 60).

163 During the first exceptional period (1657-1763), the System was temporarily in a ' periodic window', and instead of chaotic non-systemic war dynamics produced doubly periodic non-systemic war dynamics.

KEY WORDS *First exceptional period, Abnormal war dynamics, Periodic window, Chaotic non-systemic war dynamics, Doubly periodic non-systemic war dynamics).*

Systems that make a transition to chaos (a chaotic regime) show that chaos does not continue uninterrupted, but that during such transitions various periodic windows emerge. I assume that periodic windows also emerge when a system reverses from chaos. During periodic windows systems produce periodic dynamics.

I propose that the during the first exceptional period (1657-1763) the System temporarily encountered – 'fell back into' – a periodic window as a consequence of a decrease in the number of degrees of freedom of the System to two; this bifurcation I attribute to the intense rivalry between Britain and France during the first exceptional period.

During the first exceptional period (1657-1763) – constituting a periodic window – the System produced doubly periodic non-systemic war dynamics: The war dynamics repeated themselves in two dimensions; it is possible to identify two periods.

Figure 100
This figure shows fluctuations in the intensities of successive wars during the first exceptional period (1657-1763): (I(t) - I(t+1)).

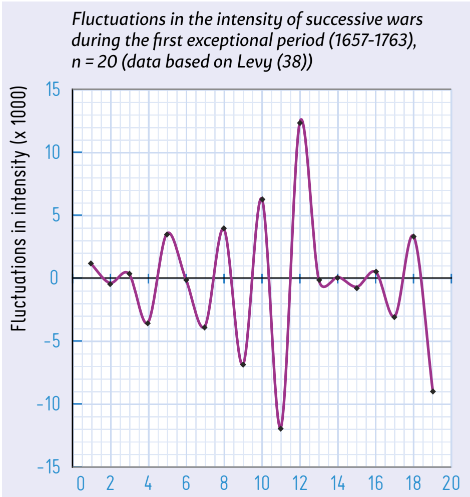
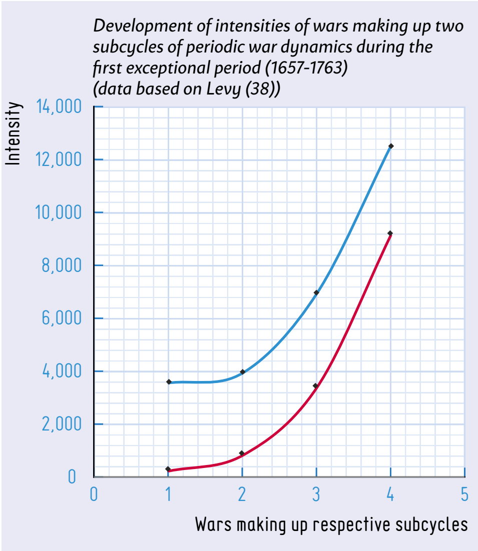


Figure 101
This figure shows the intensity of wars that make up two subcycles during the periodic war dynamics of the first exceptional period (1657-1763). The first subcycle (1667-1716) is depicted in blue, the second subcycle (1716-1763) in red.



164 The fact that the System encountered a periodic window during the first exceptional period (1657-1763), is consistent with the typical behavior of systems that transit to, or reverse from chaos.

KEY WORDS *Periodic window, First exceptional period, Chaos.*

Systems/dynamics that make a transition to chaos encounter various periodic windows: Chaos does not continue uninterrupted (23). I assume that periodic windows also emerge in case of reversals from chaos.

I assume that in 1657 the System experienced a reversal from chaos; a bifurcation from chaos to (doubly) periodic non-systemic war dynamics, and in 1763 a bifurcation back to a chaos. I attribute these bifurcations to a temporary decrease in the number of degrees of freedom of the System to two, as a consequence of the intense rivalry between Britain and France during the period 1657-1763.

I consider this behavior of the System (from chaos to periodic dynamics, and vice versa) – the emergence of periodic windows 'close' to chaos – further 'proof' for the consistency of the model (theory) I present in this study.

165 The period 1953-1989 (better known as the Cold War) qualifies as a second exceptional period because of the intense rivalries between the Unites States and the Soviet Union. Contrary to the hyper-excited war dynamics during first exceptional period (1657-1763), the war dynamics during the second exceptional period were very subdued.

KEY WORDS *Second exceptional period, Rivalry, Cold War, Subdued war dynamics.*

The intense rivalry between the United States and the Soviet Union and their respective hierarchies produced abnormal non-systemic war dynamics during the period 1953-1989. The collapse of the Eastern hierarchy in 1989 led to the resumption of chaotic war dynamics in the System. Contrary to the abnormal periodic war dynamics during the first exceptional period (1657-1763) when there was an intense rivalry between Great Britain and France, during the second exceptional period the System did not produce extreme and remarkably regular war dynamics, but very subdued war dynamics instead. Between 1953 and 1989, the System produced eight non-systemic wars; seven wars involved only one Great Power and one war only two Great Powers; only one of these wars took place in Europe. The System that started in 1495 had never before experienced such a subdued period with a length of 38 years.

The subdued nature of these wars can be attributed to the local stability of states during this period. Local stability was a consequence of states' high connectedness to issues that were all related to the rivalry between the United States and the Soviet Union. The local stability of states was further enforced by the threat of mutual assured destruction (MAD). MAD is ability of both powers to maintain a second strike capability and revenge a first strike by the rival. During the second exceptional period, the System was continuously on the 'edge' of a system-wide, but non-systemic, war.

I reasoned that the first exceptional period (1657-1763) caused a delay of about 13 years in the development of the System towards criticality and systemic war, and as a consequence, a delay in the unfolding of the finite-time singularity dynamic towards its critical connectivity threshold. Because the different nature of the subdued non-systemic war dynamics during the second exceptional period and the fact that a reference cycle for the second finite-time singularity dynamic (begun in 1945) is not yet available, the impact of the subdued war dynamics cannot be determined at this stage.

10 PROPERTIES OF WAR DYNAMICS DURING SPECIFIC PHASES OF THE FIRST FINITE-TIME SINGULARITY DYNAMIC (1495-1945).

166 The size-distributions of wars can be described by a power-law when size is defined in terms of 'fraction' and 'extent'.

KEY WORDS *Size-distribution, Wars, System.*

The figure below shows the size distribution of wars for the period 1495-2016 when size is defined in terms of 'fraction,' a relative measure calculated by dividing the number of Great Powers that participated in a war by the total number of Great Powers in the System at that time. This figure only includes wars involving at least two Great Powers. Wars that are related to the expansion of the System (Wars 88, 97, 99, 104, 105, and 109-112) (38) are excluded from this analysis.

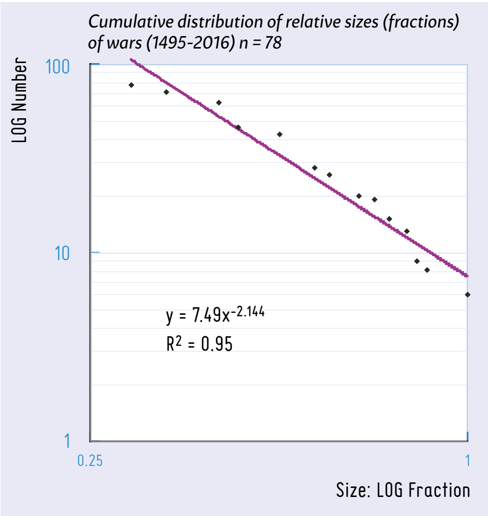


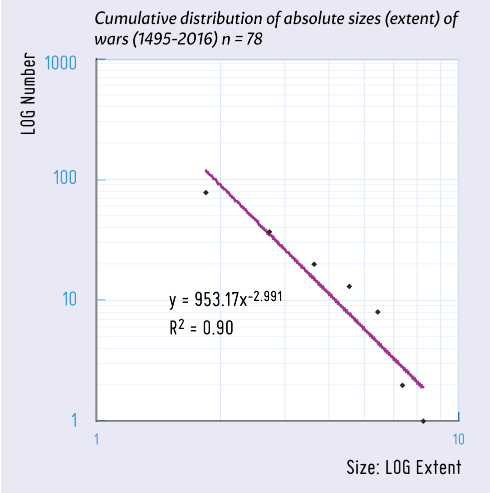
Figure 102
This figure shows the cumulative size distribution of Great Powers wars involving at least two Great Powers during the period 1495-2016. Size is defined in terms of fraction of Great Powers participating. Expansions wars (numbers 97, 99, 104, 105, and 109-112) are excluded.

If size is defined in terms of 'extent,' or the absolute number of Great Powers participating in wars, the size distribution is more or less similar as shown in the figure below.

I propose that these cumulative size distributions follow power-laws, at least for some significant part of their range. Richardson (50) and Newman (44) also observed that power-laws can describe size distributions of wars; however, they defined the size of war in terms of their intensity.

I propose that the power-law distribution of war sizes can be attributed to the chaotic nature of war dynamics; however, however this research also suggests that periodic dynamics produce power-law distributions.

Figure 103
This figure shows the cumulative size distribution of Great Powers wars involving at least two Great Powers during the period 1495-2016. Size is defined in terms of absolute number of Great Powers involved. Expansion wars (97, 99, 104, 105, and 109-112) are excluded.

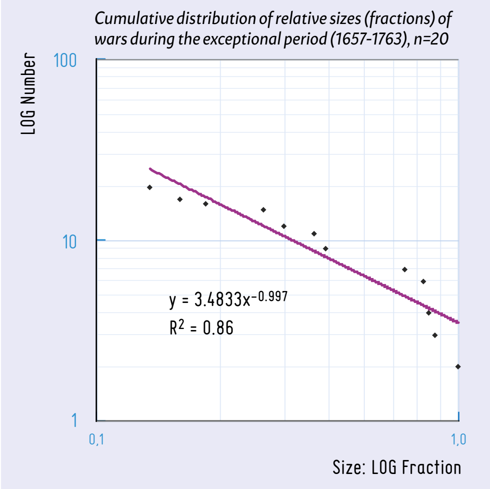


167 The size-distributions of wars during the first exceptional period (1657-1763) can be described by a power-law when size is defined in terms of 'fraction'.

KEY WORDS *Size-distribution, Wars, First exceptional period, System.*

Despite the fundamentally different nature of non-chaotic war dynamics during the first exceptional period (1657-1763), their size distribution can also be described (it seems) by a power-law. A number of mechanisms produce power-law distributions (implying fractal structures), including chaotic dynamics. The fact that the size distribution of wars during the first exceptional period can be described by a power-law shows that the presence of a power-law distribution does not prove that chaotic dynamics are responsible for the fractal size distribution.

Figure 104
This figure shows the cumulative size distributions of wars during the exceptional period (1657-1763, n = 20). This size distribution suggests that periodic war dynamics also produce a power-law distribution.



168 During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), each relatively stable period (international order) of each cycle produced a number of non-systemic wars; these war dynamics show remarkable regularities; also during the first exceptional period (1657-1763).

KEY WORDS *Singularity dynamic, second law of thermodynamics, International orders, Chaotic war dynamics, Orbits, Regularities, Damped oscillator, Exceptional period, Abnormal war dynamics, Periodic war dynamics, Subcycles.*

In this statement I look more closely at the war dynamics of the System during successive stable international orders (relatively stable periods) during the unfolding of the first finite-time singularity dynamic (1495-1945), especially the dynamics in phase state with size (in terms of fraction) and intensity as variables. The fourth international period (1918-1939) does not allow for such an analysis, due to a lack of non-systemic wars as a consequence of the (almost) infinite robustness of that particular order.

1 *Analysis of war dynamics during the first international order (1495-1618)*

In this section, I discuss the characteristics of the chaotic war dynamics during the first international order (1495-1618). The table below shows the 45 wars the System produced during the first international order.

Wars constituting nine orbits during the first international order (1495-1618) Data based on levy (38)						
Nr Levy	War/orbit	Direction	Intensity	Fraction	Start	End
1	1/1	R	119	0.60	1495	1497
2	2/1	R	45	0.20	1497	1498
3	3/1	R	60	0.20	1499	1503
4	4/1	R	29	0.20	1499	1500
5	5/1	R	269	0.40	1501	1504
6	6/1	R	145	0.60	1508	1509
7	1/2	L	261	0.80	1511	1514
8	2/2	L	343	0.40	1512	1519
9	3/2	L	57	0.20	1513	1515
10	4/2	L	43	0.60	1515	1515
11	5/2	L	420	0.75	1521	1526
12	1/3	L	958	0.50	1521	1531
13	2/3	L	41	0.25	1522	1523
14	3/3	L	249	0.75	1526	1529
15	4/3	L	384	0.50	1532	1535

Wars constituting nine orbits during the first international order (1495-1618) Data based on levy (38)						
16	1/4	L	55	0.25	1532	1534
17	2/4	L	438	0.50	1536	1538
18	3/4	L	1329	0.50	1537	1547
19	4/4	L	176	0.25	1542	1550
20	1/5	?	629	0.50	1542	1544
21	2/5	?	107	0.50	1544	1546
22	3/5	?	79	0.50	1549	1550
23	4/5	?	578	0.50	1551	1556
24	5/5	?	668	0.50	1552	1556
25	1/6	R	676	0.40	1556	1562
26	2/6	R	316	0.60	1556	1559
27	3/6	R	78	0.40	1559	1560
28	4/6	R	310	0.40	1559	1564
29	5/6	R	77	0.40	1562	1564
30	6/6	R	306	0.40	1565	1568
31	7/6	R	608	0.40	1569	1580
32	1/7	R	600	0.40	1576	1583
33	2/7	R	50	0.20	1579	1581
34	3/7	R	210	0.20	1583	1590
35	4/7	R	588	0.40	1585	1604
36	1/8	L	49	0.20	1587	1588
37	2/8	L	195	0.40	1589	1598
38	3/8	L	1086	0.40	1593	1606
39	4/8	L	24	0.20	1600	1601
40	1/9	R	175	0.33	1610	1614
41	2/9	R	70	0.17	1615	1618
42	3/9	R	23	0.17	1615	1617
43	4/9	R	58	0.14	1617	1621
44	5/9	R	69	0.29	1618	1619
45	6/9	R	173	0.14	1618	1621

Table 87 *The non-systemic wars the System produced during the first international order (1495-1618) of the first finite-time singularity dynamic (1495-1945), constitute nine orbits. Only one Great Power participated in wars marked with blue.*

When these 45 wars are plotted in phase state (defined by size in terms of fraction and intensity), it is possible to identify nine orbits. Orbits can also be identified in other international orders. In this section, I restrict myself to orbits produced by the first international order (1495-1618).

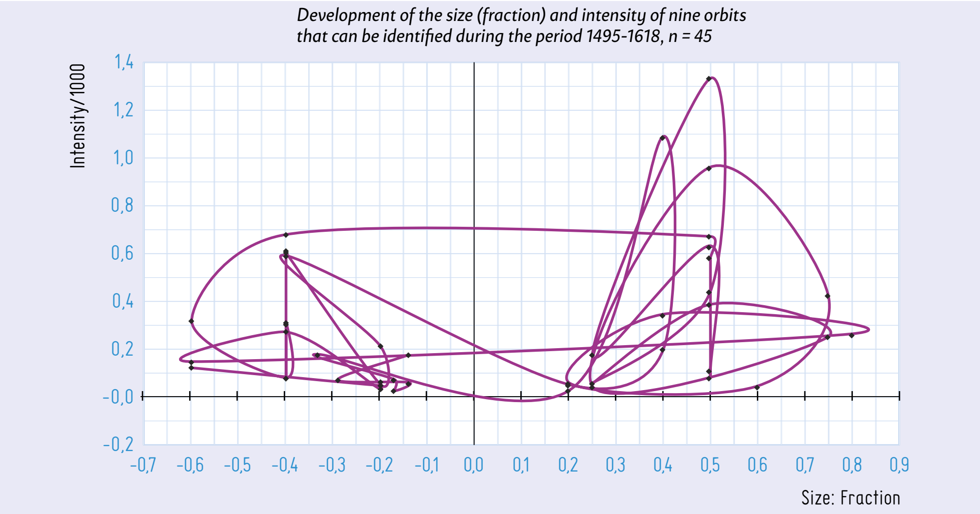


Figure 105 *This figure shows nine orbits in phase state during the first international order (1495-1618). As specified in the table above, trajectories make left or right hand orbits in phase state. In this figure, right hand orbits are projected in the left quadrant to make the presentation clearer.*

A closer look reveals that orbits differ in a number of respects. The five wars constituting the fifth orbit, for example, all had a similar size, a fraction of 0,50. As a consequence of this peculiarity, these five wars do not constitute an orbit.

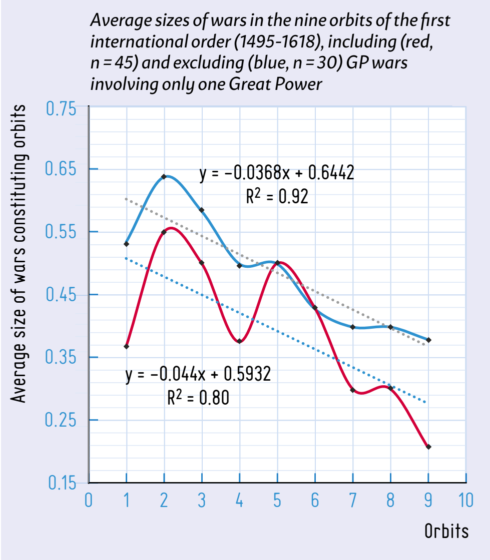
Although orbits differ, the sizes of successive orbits developed remarkably regularly, at least during the first international order. Initially, the average size of wars constituting orbits increases; average size reaches a maximum during the second orbit. The tipping point that distinguishes the low- and high-connectivity regimes of the first international order (1495-1618) was reached in 1514, during the second orbit (1511-1526).

Orbits, this analysis shows, are not random constructs and their properties develop remarkably regularly (follow a particular pattern). From the second orbit onwards, the average size of wars constituting successive orbits decreased more or less linearly. During this decrease, the order was in its high-connectivity regime. This linear decrease of the average size of wars is a consequence of the increasing local stability of states during the high-connectivity regime, and is a manifestation of the increasing connectivity of the international order, before the System eventually becomes critical.

The figure below shows two plots. The red plot follows the average size of wars constituting successive orbits, *including* wars involving only one Great Power (n = 45); the blue plot shows the average size of wars constituting successive orbits, *excluding* wars involving only one Great Power (n = 30).

The blue plot is more regular, but both plots suggest that the first international order works as a damped oscillator if orbits (comprising of a number of non-systemic wars) are used as the unit of analysis. Fluctuations in the average sizes of wars constituting successive orbits dampen over time. I attribute the dampening of these oscillations during the high-connectivity regime of the first order, to the increasing local stability of states; the increasing local stability of states is caused by the increasing connectivity of the issue network (vulnerable issue clusters) of which states are integral parts.

Figure 106
This figure shows the properties of the nine orbits the anarchistic System produced during the first relatively stable period (the first international order, 1495-1618). The properties developed very regularly: The orbits – the war dynamics during the first international order – constitute a damped oscillator. In the red plot Great Power wars with one Great Power are included (n = 45); in blue Great Power wars only involving one Great Power are excluded (n = 30).



These two plots suggest that non-systemic wars that involve at least two Great Powers are more constrained in their size-fluctuations, than wars that involve only one Great Power.

2 *Analysis of war dynamics during the second international order (1648-1792)*

In this section I discuss the characteristics of the abnormal periodic war dynamics during the exceptional period (1657-1763) and the orbit the System produced when it resumed chaotic war dynamics (1763-1792).

2.a *Periodic war dynamics during the exceptional period (1657-1763).*

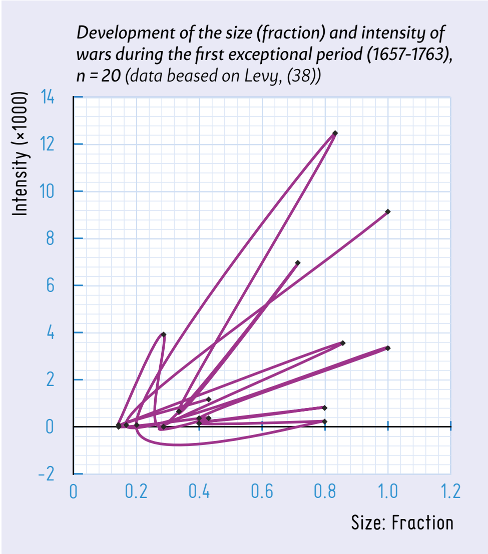
Wars during the exceptional period (1657-1763) uring the second international order (1648-1792)					
Nr. Levy	Nr.	Intensity	Size	Start	End
58	1	1170	0.43	1657	1664
59	2	11	0.14	1665	1666
60	3	392	0.43	1665	1667
61	4	42	0.29	1667	1668
62	5	3580	0.86	1672	1678
63	6	52	0.14	1672	1676
64	7	125	0.14	1677	1681
65	8	3954	0.29	1682	1699
66	9	51	0.29	1683	1684
67	10	6939	0.71	1688	1697
68	11	640	0.33	1700	1721
69	12	12490	0.83	1701	1713
70	13	98	0.20	1716	1718
71	14	245	0.80	1718	1720
72	15	144	0.40	1726	1729
73	16	836	0.80	1733	1738
74	17	359	0.40	1736	1739
75	18	3379	1.00	1739	1748
76	19	94	0.17	1741	1743
77	20	9118	1.00	1755	1763

Table 88 *Wars in this table constitute the exceptional period; their dynamics are period and not chaotic in nature. Wars 62, 65, 67, and 69 and Wars 71, 73, 75, and 77, respectively, make up the first and second cycles.*

During the life span of the second international order (1648-1792), the System produced abnormal non-chaotic war dynamics during the period 1657-1763 as a consequence of the intense rivalry between Great Britain and France; this intense rivalry caused a temporary decrease in the number of degrees of freedom (n) in the System to n = 2.

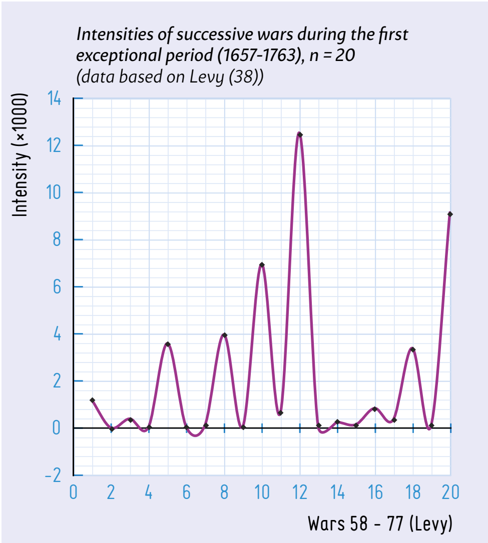
The war dynamics show periodic properties during the exceptional period.

Figure 107
This figure shows trajectories of wars in phase state during the first exceptional period (1657-1763); these trajectories do not orbit (data based on Levy (38))



The period nature of war dynamics during the exceptional period (1657-1763) becomes more evident when the intensities of successive wars and their fluctuations are examined. See the figures below.

Figure 108
During the exceptional period (1657-1763), the intensities of wars fell into two cycles, respectively consisting of twelve and eight wars.



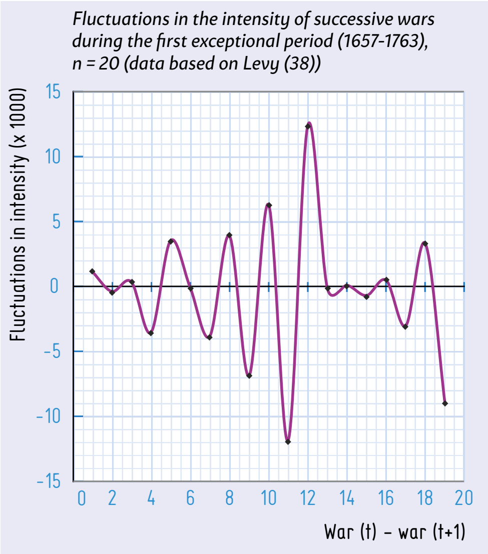


Figure 109
This figure shows fluctuations in the intensities of successive wars during the first exceptional period (1657-1763): (I(t) - I(t+1)).

It is now possible to identify two 'subcycles' in the periodic war dynamics during the exceptional period. To determine in what respect these subcycles are identical, I selected the four high-intensity wars that define the first and second subcycles respectively, and analyzed their dynamics. Wars with the numbers 62, 65, 67, and 69 constitute the first subcycle and wars with the numbers 71, 73, 75, and 77 the second subcycle (numbers from Levy (38)).

When the intensity of the wars constituting respective subcycles is compared, their identical configurations become even more evident. The correlation between wars making up the cycles is 0.999.

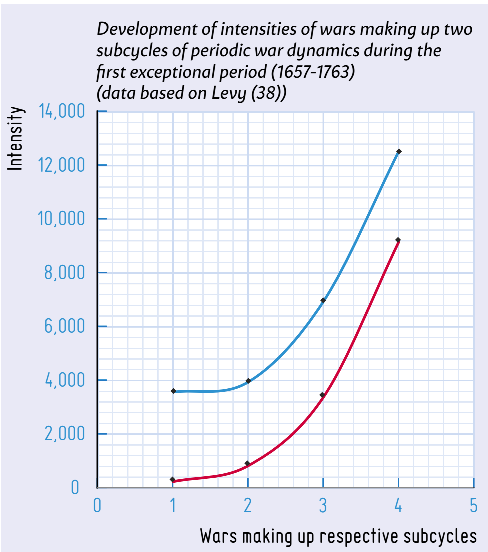


Figure 110
This figure shows the intensity of wars that make up two subcycles during the periodic war dynamics of the first exceptional period (1657-1763). The first subcycle (1667-1716) is depicted in blue, the second subcycle (1716-1763) in red.

Intensities of wars making up cycles of periodic war dynamics during the exceptional period (1657-1763) (data based on Levy (38))				
	Cycle 1 (1667-1716)		Cycle 2 (1716-1763)	
	No. Levy	Intensity	No. Levy	Intensity
1	62	3580	71	245
2	65	3954	73	836
3	67	6939	75	3379
4	69	12490	77	9118

Table 89 *In this table the wars that constitute two subcycles are specified (data base on Levy, (38)).*

Not only do the intensities of wars making up the subcycles follow identical growth rates, the war frequencies are similar. The frequency of wars making up the first subcycle is 0,082 (4/49) and the frequency of the second subcycle is 0,085 (4/47).

The regularity of wars during the exceptional period means that these periodic wars are much more predictable; chaotic war dynamics, on the other hand, are highly unpredictable because of their high sensitivity for initial conditions.

2.b *Chaotic war dynamics during the period 1763-1792 following the exceptional period (1657-1763).*

With the Seven Years' War (1755-1763), the intense rivalry between Great Britain and France was finally resolved, the number of degrees of freedom of the System increased (n > 2), and chaotic war dynamics resumed.

Wars constituting a single orbit during the second international order (1763-1792)						
Nr Levy	Nr	Direction	Intensity	Size	Start	End
78	1	L	127	0.17	1768	1774
79	2	L	149	0.17	1768	1772
80	3	L	3	0.33	1778	1779
81	4	L	304	0.50	1778	1784
82	5	L	1685	0.33	1787	1792
83	6	L	26	0.17	1788	1790

Table 90 *This table shows six wars that make up a single orbit. The System developed this orbit when chaotic war dynamics resumed following the exceptional period (1657-1792).*

During the period 1763-1792, the System produced six wars constituting a single orbit in phase state. In 1792, the System became critical and produced the second systemic war, The French Revolutionary and Napoleonic Wars (1792-1815).

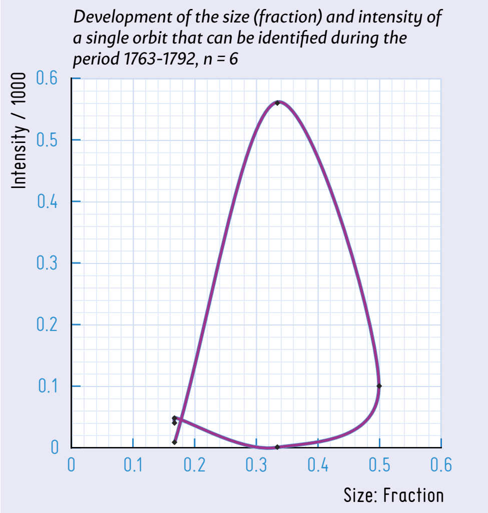


Figure 111
This figure depicts the orbit, consisting of six non-systemic wars, that the System produced following the exceptional period (1657-1763) and shortly before the second systemic war (1792-1815). The circular property of the orbit is indicative of the resumption of chaotic war dynamics.

During the life span of this orbit, the order reached the tipping point (in 1774) and states became more stable as a consequence of their high connectivity. Tensions that could not be released crystallized in underlying vulnerable issue clusters that eventually percolated the System, resulting in its criticality (in 1792).

3 *Analysis of war dynamics during the third international order (1815-1914)*

During the third international order (1815-1814) war dynamics were chaotic. The table below shows wars that were produced during the third international order.

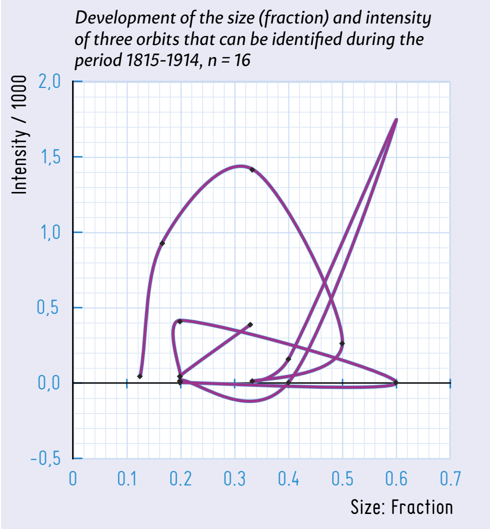
Wars constituting three orbits during the third international order (1815-1-1914)

No. Levy	No.	Direction	Intensity	Size	Start	End
86	1	L	388	0.33	1806	1812
87	2	L	51	0.20	1808	1809
89	3	L	17	0.20	1815	1815
90	4	L	3	0.20	1823	1823
91	5	L	2	0.60	1827	1827
92	6	L	415	0.20	1828	1829
93	7	L	45	0.20	1848	1849
94	8	L	20	0.20	1849	1849
95	1		4	0.40	1849	1849
96	2		1743	0.60	1853	1856
98	3		159	0.40	1859	1859

Wars constituting three orbits during the third international order (1815-1-1914)						
100	1	L	12	0.33	1864	1864
101	2	L	270	0.50	1866	1866
102	3	L	1415	0.33	1870	1871
103	4	L	935	0.17	1877	1878
106	5	L	45	0.13	1911	1912

Table 91 *This table shows 16 wars that constitute three orbits. Extension wars 97, 99, 104, and 105 are not included.*

Figure 112
This figure shows the three orbits the System produced during the life span of the third international order (1815-1914); extension wars (88, 97, 99, 104, and 105) are excluded. It can be argued whether the second orbit qualifies as such.



169 During the first international order (1495-1618), the System produced nine circular trajectories (orbits) in phase state defined by the intensity and size of wars. These orbits make up a damped oscillator.

KEY WORDS *First international order, Chaotic dynamics, Orbits, Damped oscillator.*

During the 1495-1945 period, a finite-time singularity dynamic accompanied by four accelerating cycles determined and shaped the war dynamics of the System. In 1939, the anarchistic System reached the critical connectivity threshold, and collapsed and experienced a phase transition as a consequence.

I propose that during the first relatively stable period - the first international order (1495-1618)- the System produced nine circular trajectories, or orbits, in phase state; phase state is defined by war intensity and size (fraction). Such circular trajectories in phase state are typical for chaotic dynamics.

The average size of wars constituting respective orbits decreased regularly. A closer look reveals that the size distribution not only decreased, but also show characteristics of a damped oscillation; the fluctuations died out when the last orbit was reached in 1610, shortly before the System became critical in 1618 and produced the first systemic war, the Thirty Years' War (1618-1648). The fluctuations of the damped oscillation are more pronounced when Great Power wars involving only one Great Power are included in the analysis.

Oscillation – including damped oscillations – is caused by a negative feedback loop in the dynamics of the System: during the first international order (1495-1618) the state of the System was compared to its goal, a preferred level of equilibrium between states in the System, and corrective actions (through non-systemic wars) were taken to eliminate any discrepancies with this preferred equilibrium state.

Sterman (69) explains: "In an oscillatory system, the state of the system constantly overshoots its goal or equilibrium state, reverses, then undershoots and so on. The overshooting arises from the presence of significant time delays in the negative loop." Shortly before the System became critical in 1618, the damping effect was 'complete'. The damping effect was a consequence of the increasing local stability of states in the System. The increasing local stability of states was a result of the increased connectivity of states in the network of issues in the System. Increased dampening occurred during the high-connectivity regime (1514-1618) of the first international order, that had reached its tipping point in 1514.

170 Damped oscillations can only emerge during high-connectivity regimes of cycles.

KEY WORDS *Damped oscillator, Non-systemic wars, First relatively stable period, Connectivity/ local stability effect, High-connectivity regime.*

During the first relatively stable period (the first international order, 1495-1618) of the first cycle of the first finite-time singularity dynamic which was accompanied by four accelerating cycles (1495-1945), the anarchistic System produced 45 non-systemic wars, that can be grouped in nine orbits (circular trajectories in phase state, defined by size (in terms of fraction) and intensity of wars). Analysis shows that these nine orbits developed very regularly, and constituted a damped oscillator.

During relatively stable periods (international orders) the System produces free energy – tensions – as a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems, that is then periodically released through non-systemic energy (tension) releases (through non-systemic wars).

The equilibrium of relatively stable periods is regulated – maintained – through non-system systemic wars.

This study shows that orbits constitute 'balancing-units', at least during the first relatively stable period. It is not clear, if non-systemic wars constituting orbits, are not only conceptually linked in the deterministic domain of the System (by forming discrete orbits), but also in the contingent domain through related contingent developments and events; further research is required.

The (nine) oscillations the first order produced are a consequence (obviously) of delayed responses of the System to perturbations of the equilibrium; delayed responses produce over- and undershoots.

The 'damping' of the oscillations, I attribute to the connectivity/local stability-effect that impacts on the war dynamics during relatively stable periods, once the tipping point is reached and the System is in a high-connectivity regime. As a consequence of the connectivity/local stability-effect, the relatively stable period becomes increasingly stable. Shortly before the System becomes critical, international orders are in fact highly stable, and non-system war dynamics are very restrained as a consequence. During high-connectivity regimes free energy (tensions) is not released, but stored in the System; the System is 'charging'.

The first relatively stable period of the first finite-time singularity dynamic (the first international order, 1495-1945), reached its tipping point in a very early stage: 1514. Eight out of nine orbits – when the damping can be observed – were produced during the period 1514-1618; during the high-connectivity regime of the first relatively stable period.

The reason that such a damping effect (damping oscillations) cannot be observed during high-connectivity regimes of the other three relatively stable periods (international orders) is because during the other three relatively stable periods the System produced not enough non-systemic wars (and orbits) to expose such an effect.

171 During the exceptional period (1657-1763), the System produced periodic war dynamics consisting of two identical subcycles.

KEY WORDS *First exceptional period, Abnormal war dynamics, Periodic war dynamics, Degrees of freedom.*

Contrary to the first (1495-1618) and third (1815-1914) international orders, the second international order (1648-1792) did not produce war dynamics with chaotic properties, except for during two relatively short periods: 1648-1657 and 1763-1792. I argue that during the exceptional period (1657-1763), the System produced periodic war dynamics, and that these abnormal war dynamics can be attributed to the intense rivalry between Great Britain and France. As a consequence of this intense rivalry, the degrees of freedom in the System were reduced to two for the duration of the exceptional period; for chaotic dynamics to be produced, a system must have at least three degrees of freedom.

Periodic war dynamics produced more regular and more extreme wars, at the same time. When intensities of wars are used as a measure, it is possible to identify two identical subcycles of four wars each that differ only in their amplitudes. Their frequencies and growth rates were identical.

11 SYSTEM PERFORMANCE AND EVOLVABILITY

172 The System is a coevolving system, in which selection acted on two levels: on the level of units (states) of the System, and at the level of the System itself.

KEY WORDS *Coevolution, Units, States, Selection, System, Powerful-become-more-powerful effect.*

Kauffman explains, "We can make a rough distinction between evolving complex systems and coevolving complex systems. In the former, the components of the system do not replicate, and hence selection cannot act directly on them. Instead, selection acts only on the system as a whole. In the latter, the components of the system replicate, and so selection may act on the level of the parts of the system as well as on the system as a whole." The System qualifies as a coevolving complex system; the components of the System (e.g., organizational units, states) replicat(ed), and the units' evolution/development also interact(ed) with the development of (successive) international orders. The finite-time singularity dynamic accompanied by four accelerating cycles was instrumental in this process.

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1939), the anarchistic System transformed from a sizeable collection of loosely connected and divers units (1495) into a coherent highly connected system of 25-30 highly standardized states (1939): the number of units decreased dramatically, there structures standardized, and their connectivity reached a critical level (causing the collapse of the anarchistic System).

For the System, this process – the 'mechanism' of coevolution – can be described as follows.

By organizing in increasingly larger 'units' (clusters) humans were able to develop and exploit economies of scale and scope that improved their (collective) ability to fulfill their basic requirements and survive. At a certain moment these units started interacting, at first sporadically but later more regularly.

Units (later states) started interacting on a regular basis around 1495; the intrinsic incompatibility between (increasing) connectivity and security of anarchistic System resulted in the production of (increasing amounts of) free energy (tensions) in the System.

In order to survive humans, populations and states must fulfill basic requirements. Not surprisingly some units were better able to fulfill their basic requirements, including their security, in a competitive and anarchistic environment, than others.

The urge to survive, and the need to fulfill basic initiated a selection process between units. Units 'searched' for organizational structures, but also for optimal sizes, to maximize their ability to fulfill basic requirements, in an increasingly connected System, that produced increasing amounts of free energy (tensions). The ability to produce, and deploy increasing amounts of destructive energy became a vital property of units.

The development path of these units to uniform (standardized) states shows that units also copied certain successful properties from each other to further maximize their competitiveness and survival chances.

During the unfolding of the singularity dynamic (1495-1945), the state with its specific characteristics (like central control over a certain geographic area, organization of destructive potential, and ability to 'leverage' tax income) emerged as the most effective organizational unit. In a later stage, as part of the process of expansion, the state as a legitimate organizational blueprint was also replicated through exporting this particular structure outside of Europe to ensure control over (non-core) territories and their populations.

Selection between units was however 'complemented' with – interacted with – a simultaneous selection process at the level of the System; between units/states, and successive international orders they collectively designed and implemented through systemic wars.

International orders are the product of systemic wars. Through systemic wars the anarchistic System periodically put free energy (tensions) to work that had built up in the System, to implement upgraded orders that allowed for lower energy levels in the System.

Systemic wars can be considered collective bargaining processes, during which states try to ensure that the new order that is designed and implemented ensures the fulfillment of their basic requirements during the next relatively stable period.

Dominant states used their power and influence during systemic wars to ensure that the new order that was implemented (especially) promoted their (specific) interests; this was achieved by including certain privileges in the organizational arrangements that underpinned the new order. Through this mechanism dominant powers achieved a 'powerful-become-more-powerful effect'. This effect contributed to the increasing structural stability of the System: The privileges dominant states had granted themselves, made that these states had a special interest in maintaining the status quo. The powerful-become-more-powerful effect is indicative for the selection process at the level of the System.

173 Through the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the System oscillated between subcriticality and criticality.

KEY WORDS *Singularity dynamic, Cycles, Oscillations, Criticality, Subcriticality.*

Through the finite-time singularity dynamic accompanied by four accelerating cycles the System reached four times a critical condition, resulting in systemic wars that the System used to implement upgraded orders to ensure compliance with the second law of thermodynamics. Upgraded orders ensured a lower energy state (lower tensions) in the System. Once these upgraded orders were implemented, the System retracted to a subcritical condition, resulting in relatively stable periods that ensured the undisturbed collective fulfillment of basic requirements by states in the anarchistic System.

This typical dynamic qualifies as a punctuated equilibrium dynamic; relatively long and stable periods were periodically punctuated by critical points (systemic wars) that allowed for the implementation of upgraded orders that defined the nature of next relatively stable periods, and the long-term development of the System.

174 Performance and evolvability of the anarchistic System during the 1495-1945 period was achieved through a finite-time singularity dynamic accompanied by four accelerating cycles; selection and self-organization are hallmarks of the singularity dynamic.

KEY WORDS *Singularity dynamic, Performance, Evolvability, Powerful-become-more-powerful effect.*

Selection and self-organization are essential properties of the finite-time singularity dynamic. Selection and self-organization shaped the finite-time singularity dynamic, and – 'at the same time' – the finite-time singularity shaped processes of selection and self-organization.

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles, the survivability and dominance of states in the System were increasingly determined by their ability to produce and deploy destructive energy. This ability determined if – and to what degree – states could ensure that upgraded orders that were implemented through systemic war, would support their (specific) interests. More dominant position of states ensured the implementation of more favorable international orders for these states. Favorable international orders ensured that more dominant states could become increasingly dominant, by using (to their own advantage) the privileges they had assigned to themselves. Selection and self-organization produced a powerful-become-more-powerful effect.

175 The anarchistic System developed an increasing inner cohesion, driven by connectivity growth (in the deterministic domain), and the urge to survive of humans, populations, and social systems in the contingent domain of the System. Application of the second law of thermodynamics to the System's dynamics – to the free energy it produced as a consequence of the intrinsic incompatibility between connectivity and security in anarchistic systems – ensured that the anarchistic System could (and would) renew itself on its own.

KEY WORDS *System, Cohesion, Connectivity, second law of thermodynamics, Intrinsic incompatibility, Free energy.*

Population growth resulted in increasing connectivity of states and populations in the System. Over time – during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles – states and their populations became increasingly dependent on each other for the fulfillment of their basic requirements, including for their (mutual) security in the anarchistic System.

The free energy the anarchistic System produced, was periodically and at an accelerating rate put to work through systemic wars, to implement upgraded orders that allowed for a lower energy state of the System, and to ensure compliance with the second law of thermodynamics.

'Self-renewal' is contained in the finite-time singularity dynamic accompanied by four accelerating cycles the anarchistic System produced during the 1495-1945 period: the singularity dynamic qualifies as a path dependent dynamic that 'forced' states in the System to produce increasing amounts of free energy (tensions), that then powered the further development and unfolding of the finite-time singularity dynamic – including the coevolution of states and successive international orders – that then forced states to produce increasing amounts of free energy, etc. The finite-time singularity dynamic – powered by free energy – is a self-reinforcing dynamic.

176 Status dynamics - changes in the status of states- and their 'hierarchy' typically take place during relatively stable periods.

KEY WORDS *Status dynamics, Relatively stable periods, Systemic wars, International orders.*

Another observation regarding status dynamics needs explanation, namely the typical timing of status changes. Levy's data shows that status changes typically take place during relatively stable periods *preceding* systemic wars, not *during* systemic wars (38). I argue that status changes that occur during relatively stable periods are subsequently put into effect during the systemic war that follows. Both relatively stable periods and systemic wars, have, with regards to status dynamics, a function to fulfill.

Systemic wars are events that occur when 'new' Great Powers – that have acquired their new status by amassing power and influence during the preceding relatively stable period – effectuate (implement) their newly acquired status, by designing and implementing upgraded orders, with other dominant states.

Great Powers accomplish this by including favorable arrangements that specifically enhance their interests in a new order. As a consequence, this new order better reflects the actual and relative power and influence positions of states in the System.

Great Powers, it should be noted, not only derive their status from power (capabilities) they amassed, but also from their ability to transform these capabilities into useful influence and to achieve favorable political ends. Systemic wars are not just about causing the destruction of issues and tensions; systemic wars are also about creating effective orders, and ensuring further growth.

177 This study shows that there are similarities as well as a number of differences between the dynamics of the anarchistic System and of the class of systems that Kauffman and Bak et al. describe. The finite-time singularity can be considered a multi-level optimization dynamic. The System – through the finite-time singularity dynamic accompanied by four accelerating cycles – 'balanced' criticality and sub criticality to maintain its performance and evolvability.

KEY WORDS *System, Regimes, Multi-level optimization, Phasing.*

Whereas Kauffman (36) and Bak et al. (3), (4), (5) explicitly attribute optimal performance and evolvability of certain systems to critical points of these systems, the highly optimized dynamics of the System are much more 'hybrid', and suggest that Kauffman's and Bak's hypotheses need some nuance.

During the 1495-1945 period the anarchistic System simultaneously optimized its dynamics at 'different' levels of the System, and by doing so, ensured the System's optimal performance (the fulfillment of basic requirements by uneven states) and optimal evolvability (its ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars). The anarchistic System optimized its dynamics at the level of the singularity dynamic, but also at the level of the components of successive cycles, that is during relatively stable periods and systemic wars. The System not only optimized certain behavior (designing and implementing change) at the critical point of the System (i.e., during systemic wars), but also during relatively stable periods through chaotic non-systemic war dynamics. The fact that the chaotic non-systemic war dynamics (45 non-systemic wars) during the first international order (1495-1618) constituted a damped oscillator at 'orbit-level', also is indicative for the multi-level optimization of the System. The non-chaotic war dynamics during the first exceptional period (1657-1763) and their sub-optimal effects (their 'negative' impact on the development and unfolding of the singularity dynamic), further support these assumptions.

Overall the System – through the finite-time singularity dynamic (1495-1945) – was able to strike an optimal balance between relative stability on the one hand and timely change on the other.

If Kauffman's terminology is applied the 'regime phasing' of the System is as follows: To begin with, until 1495, the System did not qualify as a system at all (a system in fact did not exist). The collection of organizational units in Europe, rudimentary state structures, city-states, and various types of coalitions, were simply insufficiently connected to qualify as a coherent 'system.'

However, that changed around 1495, when a system (i.e., the System) emerged, as historians also observe. Historians observe that, from around that moment in time, states started interacting in an organized manner. In systems terminology, at that point, the collection of units reached a percolation threshold (not to be confused with a percolation condition, a prerequisite for criticality (68)). According to Watts' model and terminology, in 1495, the 'collection of units' crossed the lower boundary of the war window, and from that moment onward, the connectivity of the units/states of the System (organizational units) started shaping the (war) dynamics of the System.

During the period 1495–1945, the System 'produced' a finite-time singularity dynamic accompanied by four accelerating cycles, that ultimately resulted in a dual-phase transition when the System in 1939 reached the critical connectivity threshold. The finite-time singularity dynamic was instrumental in the implementation of two dedicated non-anarchistic hierarchies in Europe, constituting a next level of SIE that ensured that the System complied with the second law of thermodynamics.

Because of some fundamental differences, I avoid using the term 'complex' regime as defined by Kauffman. In Kauffman's terminology, 'complex regime,' 'at the edge of chaos,' and 'criticality' are synonyms. As I already explained, the System shows much more complicated behavior. In case of the singularity dynamic, a number of related optimizations at different levels of the System were accomplished simultaneously. The finite-time singularity can be considered a multi-level optimization dynamic.

Four times the System reached a critical point. Systemic wars are manifestations of criticality of the System; according to Kauffman's terminology the System was four times 'poised at the edge of chaos'. Through criticality – systemic wars – the System could (four times) reset its parameters and initial conditions. Each 'reset' caused the System to become subcritical again. During relatively stable periods the System in fact was sub critical. Sub criticality – relative stable periods – allowed for the balanced fulfillment of basic requirements by uneven states in the anarchistic System.

Through the (just mentioned) phase transition (accomplished through the fourth systemic war, The Second World War,1939-1945) Europe transited to what can be qualified (in Kauffman's terminology) to an ordered state; at least within the two dedicated non-anarchistic hierarchies that were imposed in respectively Western and Eastern Europe. Through the phase transition the core of the System (Europe) made a transition from a 'singularity-dynamic regime' (1495-1939) to an ordered regime.

Whereas Kauffman suggests that the 'edge of chaos' - criticality - is the attractor of certain categories of complex systems that ensures their optimal performance and evolvability, this study shows that the System achieved optimal performance and evolvability, by periodically becoming critical (and using this condition to upgrade its order to better meet the requirements of the second law of thermodynamics (a lower energy state)), and subtracting to a subcritical 'condition' that allowed for (further) growth of the System. The System – through the finite-time singularity dynamic accompanied by four accelerating cycles – 'balanced' criticality and sub criticality to ensure its performance and evolvability. The System could only sustain short intervals of criticality (because of the energy requirements, and the destruction this condition caused), and subtracted into a sub criticality, once the critical periods were 'used' to design and implement upgraded orders.

178 In the System chaotic war dynamics are a prerequisite for order.

KEY WORDS *Singularity dynamic, Chaotic dynamics, Order.*

During the period 1495–1945, the singularity dynamic was accompanied by four cycles. Each cycle consisted of a relatively stable period and a systemic war. During relatively stable periods (that is, during the life span of international orders), the System 'normally' (except for the exceptional period 1657-1763) produced chaotic war dynamics. Following Kauffman's terminology, relatively stable periods must be denoted as 'disordered' when the nature of its chaotic non-systemic war dynamics is taken as the measure. However, in case of the System the 'disordered' qualification is misleading. During relatively stable periods (when war dynamics normally are chaotic in nature), there certainly was a certain degree of functional order ('international order') that ensured the balanced fulfillment of basic requirements by uneven states within the anarchistic System.

The damped oscillator *chaotic* non-systemic wars produced during the first international order (1495-1618), and hyper-exited *non-chaotic* non-systemic wars produced during the first exceptional period (1657-1763), and their impact on the development of the singularity dynamic, is convincing proof that chaotic dynamics can create order, and that chaos – at least to a degree – can be a prerequisite for order.

I assume that this 'quality' of chaotic war dynamics lies in the intrinsic inhibition of this type of dynamics, provided by a third degree of freedom in the System.

179 Through upgraded orders the carrying capacity of the anarchistic System was (and is) periodically enhanced to allow for further population growth and development.

KEY WORDS *Singularity dynamic, Upgraded orders, SIE, Carrying capacity, Population Growth.*

During the unfolding of the first finite-time singularity dynamic which was accompanied by four accelerating cycles (1495-1945), Europe - the (core of the) anarchistic System developed from a total population of circa 83 million in 1495 to 523 million in 1939. At the same time Europe (the core of the System) developed from a sizeable collection of diverse and loosely connected units, into a highly connected anarchistic System of 25-30 highly standardized states with fractal structures, that also expanded their political control to non-core territories (outside Europe).

The first finite-time singularity dynamic was instrumental in this process of growth, integration and expansion, by ensuring that order and disorder were balanced in the anarchistic System. The System – the finite-time singularity dynamic – achieved this by periodically implementing upgraded orders through systemic wars (consistent with the second law of thermodynamics).

The dynamics and development of the System, can also be understood from a 'biological' perspective. During the 1495-1945 period (but also thereafter) population growth was counterbalanced by limitations of resources, but also by limitations of organizational structures (the structure of international orders). Typically, during relatively stable periods (international orders) the intensity of rivalries between states in the System increased because of growing populations and depletion of the System's resource pool, and limitation to its organizational structures.

Systemic wars can also be understood as necessary restructuring of the 'resource pool' to ensure the carrying capacity of the anarchistic System; the ability of the System to sustain the fulfillment of basic requirements of growing populations of states in the anarchistic System.

12 OPTIMIZATION AND FRACTAL STRUCTURES

180 It is possible to identify 'fractal structures' in the System.

KEY WORDS *Optimization, Fractals, War sizes, State structures, Dynamics during systemic wars, Military organizations, Casualty dynamics.*

Depending on the fractal structures in question they can (in some cases) be related to criticality (critical phenomena), the chaotic nature of war dynamics, but also – in general – to optimization processes; it seems that fractals in dynamics and structures of the System, as is the case with fractals in biological systems, often point to optimization where distribution is involved and contradictory requirements must be reconciled.

In this statement I discuss 'where and why' power-law distributions – implying fractality – can be found in the dynamics and structures of the System, what this could mean, and how these distributions are, at least in some cases, related.

1 *War sizes*

The size distribution of wars can best be described with power laws: when size is defined as the number of casualties (50) and when it is defined as the fraction of Great Powers actively involved in Great Power wars.

I assume that the power-law distribution of war sizes, as defined in terms of fractions, can be attributed to the chaotic and periodic nature of non-systemic war dynamics. The distortion of the power law, I argue, can be attributed to the hyper-excited condition of the System during the exceptional period. This distortion produced a high number of system-wide non-systemic wars.

2 *State structures*

During the 1495-1945 period, the anarchistic System developed from a large number of loosely connected and divers units, into a highly connected system of about 25-30 highly standardized states, that were 'organized' to produce and deploy increasing amounts of destructive energy, at accelerating rates.

In the article titled "*Hierarchical organization of cities and nations*" observe that geographical and demographical data shows "that the nation population and nation area distributions obey power laws" (40). Malescio et al. show that this is the case for all nations of the world including Europe. The authors studied the properties of these power-law distributions with the purpose of determining whether size distributions of populations and area distributions of states obey the same power laws as the population and area distributions of cities. They show that this is not the case and suggest that different mechanisms underlie these regularities (power laws). The point now is, in the context of this study, that such a power-law distribution exists;

I argue that these fractal structures were carved out during (by means of) successive systemic wars.

The fractality of state-structures point to optimization: fractal state structures ensure that during relatively stable periods (international orders) the production of free energy can be minimized, while during systemic wars, fractal structures contribute to the optimized distribution of destructive energy.

3 *Dynamics (activities) during systemic wars*

Systemic wars represent critical points (criticality) in the System.

At the critical point (that is during systemic wars), in the terminology of Kauffman (36) a system consists of clusters of 'frozen' and 'unfrozen islands'; I propose that the System during systemic wars (critical periods) consisted of clusters of 'war' and 'no-war' activities (at different scales of the System), and that their size distribution can be best described by a power law. Due to lack of data, I cannot prove this directly.

I argued (in the previous point) that the fractal structures of states in the System are carved out by fractal war activities during systemic wars (and vice versa). I argue – in other words – that fractal state structures and war activities during systemic wars are closely related phenomena that reflect key structural and dynamical characteristics of the System. I consider the presence of these fractal state structures strong evidence for the fractal nature of war activities during systemic wars.

I further assume that the fractal activities of systemic wars and their physical outcomes, point to 'optimization': the optimization of the distribution of destructive energy in the System, and the (inherent) ability of the System to maintain a certain balance that enables the fulfillment of basic requirements by uneven states in an anarchistic System (necessary for their collective growth and survival).

4 *Military organizations and capabilities*

Military organizations, as I show in the figures below, have fractal structures. Each structure, at each level, consists of a number (of often three) self-similar substructures. There is self-similarity in organizational structures, as well as in capabilities that are available at different levels of organization.

The primary function of military organizations is to protect the state and its population(s) against (external) threats. Military organizations achieve this by (preventively) deploying destructive energy, as dictated by the integrative structures (political leadership) of states. Projection of destructive energy – military activities – is about the distribution of destructive energy.

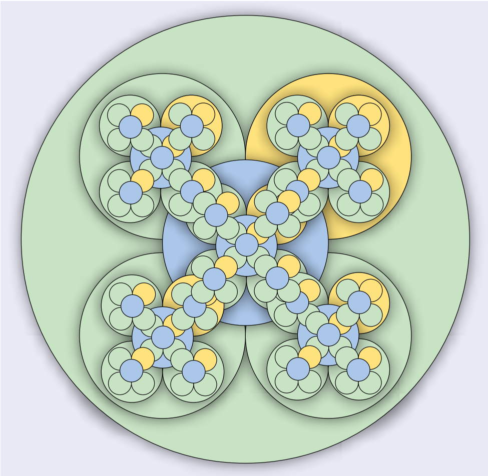


Figure 113
This figure depicts a military fighting unit: each level of organization has a similar basic structure.

I argue that the increasing fractality of military organizations and their capabilities is closely related to the other fractal structures I discuss in this statement. The crystallization of military organizations and capabilities in fractal structures were also the product of the singularity dynamic (1495–1945), its path-dependent nature, and were closely related to the narrowing of the competition between states, that were constantly 'forced' to improve their war-fighting capabilities. States increasingly had to focus on producing increasingly amounts of 'superior' destructive energy and on methods (doctrines, strategies, and tactics, etc.) that ensured their effective and efficient deployment.

Regarding the deployment of destructive energy (military capabilities) 'on the battlefield', military organizations must reconcile and optimize a number of contradictory requirements. Military organizations must e.g. strike an optimal balance between the concentration of sufficient and decisive amounts of destructive energy, and the risks concentration of force poses for their own destruction by the adversary; an optimal balance between concentration and dispersal must be achieved, to ensure accomplishment of the mission, and survival of the own military organization.

The span of control, defined as the number of military subunits that a commander (the next level up) can effectively control, is another factor that contributed to the emergence of fractal military organizations; military operations are also about information processing and achieving an optimum in that respect.

Optimization of the span of control also requires balancing and trade-offs to achieve optimum results. In case the maximum achievable span of control is not utilized, the available resources and organization are not used to maximum effect and the organization has unnecessary communication links and probably too many hierarchical levels/layers (41). On the other hand, if the maximum span of control is exceeded, the control system will be saturated and information will not be accurate, negatively affecting 'situational awareness' and the quality of decision-making.

5 ***Casualties in wars***

To get a better understanding of fractals, I also studied the 'casualty dynamics' of the Iraq War during the period March 19th 2003 to May 21st 2005 (48). I chose to study this particular war because of the availability of accurate data; such data of wars during the period 1495–1945 is not available. The casualty figures I show here are based on the '*Iraq Coalition Casualty Count*' (www.icasulaties.org), and only include the casualties of the so-called 'Coalition Forces.' With the term 'casualty dynamics,' I refer to the size distribution of clusters of casualties that occurred on a particular day during that period of time. I expected casualty dynamics to have fractal properties, assuming that fractal (military) organizations and capabilities carve out fractal effects. That indeed seems to be the case. I consider this result consistent with a number of my assumptions.

I assume that this particular power-law 'casualty-size' distribution is (also) related to the fractal organization of military organizations and capabilities, as well as how these units are deployed and fight, adopting self-similar patterns to achieve space-filling, hierarchical branching networks, to deploy destructive energy (as efficient as possible). These space-filling, hierarchical branching networks are required to accomplish effective deployment of destructive energy against an enemy that follows a more or less similar logic. At the same time military organizations spread their capabilities to avoid destruction and maintain a certain flexibility to regroup on the battlefield.

These requirements also apply at the operational and strategic levels of warfare and are contained in the principles of war.

As I mentioned in the 'introduction' of this statement, I assume that these fractal structures are related: all these fractal structures are one way or the other related to free energy (tensions) - its production and distribution - to which the second law of thermodynamics applies.

Fractal structures and optimization in the System

	Fractal structure	Optimization
1	War sizes	Optimizing free energy releases to achieve and maintain a functional balance
2	State structures	Minimizing free energy (tension) production (during relatively stable periods), and optimizing destructive energy deployment (during systemic wars)
3	Dynamics (activities) during systemic wars (criticality)	Optimizing of order versus disorder (during systemic wars), to 'compute' and implement upgraded organizational arrangements, that allow for a lower energy state of the System
4	Military organizations and capabilities	Optimizing distribution of destructive energy
5	Casualties in wars	Optimizing distribution of destructive energy

Table 92 *In this table I show the various fractal structures that can be identified in the System, and their contribution to the optimization of the anarchistic System.*

181 In the anarchistic System (1495-1945) there was synchronized multilayered optimization.

KEY WORDS *Synchronized multilayered optimization, Singularity dynamic, Acceleration, Cycles, Orbits, Non-systemic wars, Systemic wars, Chaotic dynamics.*

It is possible to distinguish a number of dynamics at different 'levels' of the anarchistic System; not only were these separate dynamics highly optimized, but also their mutual relationships. The following levels (dynamics) can be distinguished:

1 ***The finite-time singularity dynamic accompanied by four accelerating cycles***
Through the finite-time singularity dynamic (1495-1945) the performance and evolvability of the System were simultaneously optimized, ensuring the balanced fulfillment of basic requirements of uneven states in an anarchistic System, and the System's timely adaptation to changed circumstances. Growing connectivity of the System 'forced' the System to implement upgraded orders – through systemic war – at an accelerating rate. Ultimately, when in 1939 the anarchistic System reached the critical connectivity threshold, the anarchistic System produced infinite amounts of free energy (tensions), collapsed and produced a dual-phase transition in response. By simultaneously implementing two dedicated non-anarchistic hierarchies in the core of the System (Europe), and the first global international order at a global scale, (continued) compliance with the second law of thermodynamics and survival of states and their populations was assured.

2 ***Cycle-level (each cycle consisting of a relatively stable period (international order) followed by a systemic war)***
Each cycle consisted of a relatively stable period (international order) followed by a systemic war. During relatively stable periods, states and their populations focused on the balanced fulfillment of their basic requirements; within an 'order' (security setting) that was implemented during the preceding systemic war. During the life cycle of a relatively stable period, the System evolved from a low- to a high-connectivity regime; connectivity growth was the driver of this development. During high-connectivity regimes tensions in the anarchistic System could not be (sufficiently) released, and were 'stored' in the System. Instead of being released, tensions (free energy) crystalized in underlying vulnerable issue clusters, that eventually percolated the System and resulted in a critical condition of the System and systemic war. During systemic wars the System – states in the System – collectively designed and implemented upgraded orders, that allowed for a lower energy state, and a next relatively stable period. At cycle level performance and evolvability were (also) balanced, to achieve optimal results.

3 ***The level of relatively stable periods***
During relatively stable periods, the System tries to maintain a certain equilibrium – tension level – through the order that was implemented during the preceding systemic war (critical period). In order to achieve this, the System produced non-systemic wars that – at a closer look – made up distinct 'orbits' in phase state. A closer look reveals that the dynamics of these orbits – each orbit consisting of a number of non-systemic wars – behaved as a damped oscillation, that eventually – shortly before the collapse of the international order (the next systemic war) – faded away. I consider these orbits, which developed very regularly (especially during the first relatively stable period (1495-1618), another indication of the multilayered optimization of the dynamics of the anarchistic System.

4 ***The level of orbits***
Except for the first exceptional period (1657-1763), the System produced chaotic non-systemic war dynamics that produced orbits (circular trajectories) in phase state (defined by intensity and size). Especially during the first relative period (1495-1618) these orbits developed very regularly, and had the properties of a damped oscillation. Each consecutive orbit – consisting of a number of non-systemic wars – can be considered a 'coordinated' response of the System to re-establish the equilibrium of the relatively stable period (international order) that was implemented through the preceding systemic war. The oscillations suggest that these corrections (these responses) were produced with a time delay, causing over-corrections (overshoots), that than triggered counter-corrections, that were also delayed. The dampening of successive oscillations – that eventually faded away shortly before the System became critical again and produced a systemic war – can be attributed to the increasing local stability of states during high-connectivity regimes. As discussed in this study: high-connectivity regimes impose limitations on the System's ability to produce non-systemic wars.

5 ***The level of systemic wars***
Systemic wars also are highly optimized dynamics. During systemic wars dysfunctional issues and tensions are destroyed and states collectively design and implement upgraded orders, that ensure the fulfillment of basic requirements of uneven states in the anarchistic System.

Not only are these separate dynamics (levels) as such highly optimized, but also their relationships. The second law of thermodynamics (in the deterministic domain), and the urge to survive of states and their populations (in the contingent domain) are at the heart of these multilayered optimization processes.

182 The fractal nature of systemic wars and the crystallization of states in the System in fractal structures, are related phenomenon, and indicative for the optimization of the System, consistent with the demands of the second law of thermodynamics.

KEY WORDS *Singularity dynamic, Optimization, Fractal structures, Fractal state-structures, Systemic wars.*

In this statement I discuss two related hypotheses. The first hypothesis concerns a relationship that I assume exists between fractal properties of systemic war activities, and the fractal size distribution of states in the System; I assume that these fractal structures (the power-law size distribution of states) were carved out through successive systemic wars (systemic wars are manifestations of criticality of the System), and that these fractal state-structures in their turn, contributed to the fractal nature of systemic wars.

The second hypothesis concerns not the 'how', but the 'why' of these fractal structures: I assume that the System crystalized into fractal states structures, because fractal structures are optimized structures that meet the demands of the second law of thermodynamics, that ensure the minimization of the production of free energy (tensions) during relatively stable periods (consistent with the principle of least free energy, related to the second law of thermodynamics), and the optimization of the distribution of destructive energy during systemic wars.

1 *The relationship between the fractal nature of systemic wars and fractal state-structures*

During the unfolding of the first finite-time singularity dynamic (1495-1945), the System developed from a sizeable collection of loosely connected and divers units (1495), into a highly connected coherent System, consisting of about 25-30 highly standardized states, that had moreover crystalized in fractal structures (1939). The finite-time singularity dynamic accompanied by four accelerating cycles was 'responsible' for this outcome; the singularity dynamic itself was a product of the second law of thermodynamics and a number of other deterministic laws and principles; four times (during critical periods) the System upgraded its order through systemic wars, to allow for lower energy states of the System. These upgrades included changes in the System's physical structure. I assume that the eventually fractal nature of the anarchistic System – the fact that the size distribution of states in the System could be best described by a power law, when the System was in the fourth relatively stable period (1918-1939) – was an outcome of the fractal nature of systemic wars. Systemic wars are manifestations of criticality of the System; critical systems typically have fractal structures. Systemic wars – as a consequence of their nature – carved out fractal state-structures.

2 ***Optimization of free energy (tension) production and destructive energy distribution***

The first finite-time singularity accompanied by four accelerating cycles (1495-1945), was about (multi-level) optimization (as is the case with the second singularity dynamic, 1945-...); the singularity dynamic balanced order and disorder, ensured optimal performance and evolvability, and enabled 'optimized' population growth in the anarchistic System. This was 'accomplished' by the second law of thermodynamics and a number of other deterministic laws and mechanisms that apply to the free energy that is produced in the anarchistic System, as a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems.

The second law of thermodynamics ensured that the production of free energy (tensions) was minimized, by implementing orders that allowed for lower energy states, and the distribution of destructive energy in the System was optimized. To achieve this - to ensure compliance with the second law of thermodynamics, the System crystalized in fractal structures.

Smaller states fulfill an important role in balancing the System and helping to prevent the production of tensions and free energy. Smaller states form 'buffers' between rival Great Powers. The 'creation' of Belgium in 1830 as a sovereign state, is an interesting case. Belgium was created with the explicit aim to structurally decrease tensions that tended to build up in the System and could threaten the System's status quo. The creation of Belgium can be considered a 'correction' by Great Powers of the time, to the third international order (1815-1914), that was implemented following the second systemic war (1792-1815, the French Revolutionary and Napoleonic Wars). I argue that the addition of Belgium to the System contributed to the (further) 'fractalization' of the System's structure.

183 The number of orbits the finite-time singularity dynamic accompanied by four accelerating cycles would have produced during the 1495-1945 period, assuming the System's non-systemic war dynamics were not disturbed during the first exceptional period (1657-1763), can be estimated by interpolating the number of appearances of related types of dynamics. The total number of orbits the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) would have produced is 16.

KEY WORDS *Singularity dynamic, Cycles, Orbits, Non-systemic wars, Exceptional period, Reconstruction.*

I make a distinction between four types – 'levels' – of dynamics in the anarchistic System during the 1495-1945 period: (1) a finite-time singularity dynamic, (2) cycles, (3) orbits, (3) and (4) non-systemic wars: non-systemic wars are grouped in orbits; orbits are produced during relatively stable periods of cycles, and four cycles make up the finite-time singularity dynamic. The finite-time singularity dynamic (number of appearances finite-time singularity: 1), was accompanied by four cycles (number of appearances cycles: 4). Each cycle consisted of a number of orbits; during the first cycle (1495-1648), the System produced nine orbits. During the second cycle (1648-1815) the dynamics of the System were temporarily distorted (during the first exceptional period, 1657-1763), and the number of orbits cannot be determined. During the third (1815-1914) and fourth (1918-1945) cycle, the System produced respectively two and zero orbits. The total number of orbits is not clear.

During the unfolding of the finite-time singularity (1495-1945), the System produced 97 non-systemic wars, expansion wars not included (number of appearances of non-systemic wars: 97).

In order to determine the total number of orbits the System produced during the 1495-1945 period, assuming that the non-systemic war dynamics during the second cycle were not temporarily distorted, I interpolated the number of appearances of the other (three) (types of) dynamics. Interpolation of the series (empirical data, (1 - 4 - X - 97) shows that during the 1495-1945 period the System would have produced 18 orbits in total (X = 18), if its dynamics were not temporarily disturbed during the first exceptional period (1657-1763).

The distribution of the number of appearances of types of dynamics in the System (1495-1945), qualifies as a Zipfian distribution: A discrete power-law probability distribution.

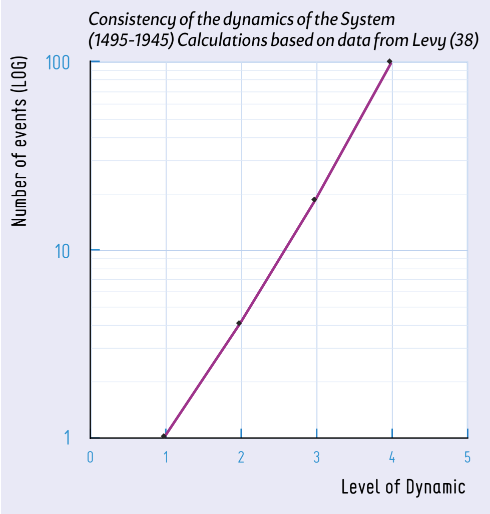
Because the anarchistic System produced respectively 9, 3 and 0 orbits during respectively the first, third and fourth cycles, this means that the System would have produced 6 orbits (18 - (9 + 3)) during the second cycle, if its dynamics were not disturbed during the first exceptional period (1657-1763); this implies that the number of orbits during successive cycles would have decreased linearly (9 - 6 - 3 - 0).

Consistency of dynamics of the System (1495-1945)
Calculations based on data from Levy (38)

Level	Dynamic	Number of occurrences	Remarks
1	Finite-time singularity	1	
2	Cycle	4	Accelerating
3	Orbit	18	Number determined through interpolation.
4	Non-systemic wars	97	During successive relatively stable periods (international orders) the System produced respectively: 45 - 34 - 16 - 2 non-systemic wars; expansion wars excluded.

Table 93 *This table shows the number of occurrences of four types of dynamics in the System during the 1495-1945 period.*

Figure 114
This figure shows the number of non-systemic wars (97, nine expansion wars excluded), orbits (18) and cycles (4), that constituted the first finite-time singularity (1495-1945). The number of occurrences of respective dynamics qualify as a Zipfian distribution.



184 The number of orbits the System would have produced during the second cycle (1648-1815) if its non-systemic war dynamics were not disturbed during the first exceptional period (1657-1763) is five.

KEY WORDS *Singularity dynamic, Cycles, Orbits, Non-systemic wars.*

During the first, third and fourth cycles the System produced respectively nine, three and zero orbits, as my analysis (based on Levy's dataset) shows. This leaves six orbits (the total is 18) for the second hypothetical (undisturbed) cycle.

As I show in below figure, a distribution of respectively 9-6-3-0 orbits during respective cycles, means that the number of orbits during the unfolding of the finite-time singularity dynamic decreased linearly.

As I explained, a total number of 18 orbits implies a Zipfian distribution for the appearances of four types of dynamics in the System during the 1495-1945 period.

Both distributions are very regular; I assume that this is not a coincidence and (additional) evidence for the consistency of the finite-time singularity (1495-1945) and its components (levels), and for the theory developed and presented in this study.

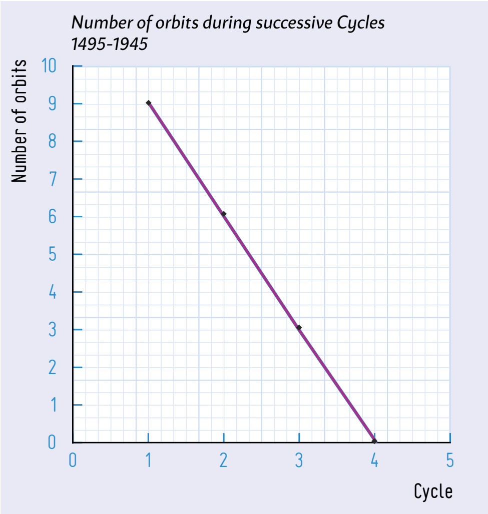


Figure 115
This figure shows the number of orbits the System would have produced during successive cycles if the System's non-systemic war dynamics were not disturbed during the first exceptional period (1657-1763). The number of orbits of the first, third and fourth cycle (respectively: nine, three and zero) is based on empirical data. The number for the third cycle (six) is determined by interpolation.

185 Assuming non-systemic wars have fractal structures, it is possible to quantify their substructures through extrapolation.

KEY WORDS *Fractal structures, Number of occurrences*

Non-systemic wars can be considered the 'basic' building blocks of the finite-time singularity dynamic the System produced during the 1495-1945 period. However, non-systemic wars themselves also consist of further (smaller) building blocks; they are fractal in nature. I assume that the structures of building blocks (levels) of non-systemic wars follow the same logic, as the building blocks (cycles, orbits and non-systemic wars) of the finite-time singularity dynamic.

If the distribution of the number of occurrences (of levels) of dynamics is extrapolated it is possible to determine the number of substructures/sub dynamics of the System, during the 1495-1945 period; see below table.

Number of occurrences of building blocks of non-systemic wars 1495-1945

Level	Dynamic	Number of occurrences
5	Campaign	394
6	Battle	1782
7	Engagement	8045
8	Fire-fight	36449

Table 94 *This table shows the speculative number of occurrences of the building blocks of non-systemic wars, assuming that the same logic applies to their distribution as to the number of occurrences of the building blocks of the first finite-time singularity dynamic.*

It is possible (as another thought experiment), to link the number of occurrences of successive dynamics (levels; 5, 6, 7, ...) to the fractal structures of military units (army group, army, army corps, division, brigade, regiment/battalion, company, platoon, section), as they formed (developed) over time, during the unfolding of the finite-time singularity dynamic (1495-1945) in order to achieve optimal (battle-field) results. The question if – and how – they match.

I assume that specific (levels of) dynamics involved units with specific sizes; level 7 dynamics (engagements) for example, could correspondent with 'battalions', whereas fire-fights (one level of dynamics down) with 'companies' (one level of organization down).

Typically, military units consist of three to four (self-)similar sub-units; their multiplication factor is circa 3,5. The growth rate (multiplication factor) of successive dynamics on the other hand is circa 4,6. They do not exactly – but only approximately – match. Can this difference be explained?

It seems, that the lower the level of organization of military units, the higher their interaction (fighting) frequency. That does make sense; not every action at a certain level of organization (for example company-level), necessarily involves the next level up (battalion-level); units also conduct 'independent' military operations at their level of organization.

Further research is required to determine the exact relationship between the fractal structures of military units, and the number of occurrences of certain levels of non-systemic war dynamics.

186 The dynamics of the System were and are highly integrated.

KEY WORDS *Singularity dynamics, Divers units, Standardized states, second law of thermodynamics, Integration, Expansion, Fractality.*

The finite-time singularity dynamic accompanied by four acceleration cycles that unfolded during the 1495-1945 period, transformed Europe from a large number of divers and loosely connected units (1495), into a highly integrated system of a significant lower number of highly standardized states (1939). Not only became states eventually the standard units ('building blocks') of the System, during the unfolding of the singularity dynamic, their sizes and forms also increasingly crystallized into fractal structures.

Shortly before the anarchistic System's collapse in 1939 their size distribution could be best described by a power law. These fractal structures were highly functional and ensured that the production of tensions in the anarchistic System and the deployment – distribution – of destructive energy during systemic wars, were optimized. The development of these particular (fractal) properties of the System also is attributable to the second law of thermodynamics.

At the same time as these transformation processes unfolded in the core of the System, European units (states) also expanded their control outside

Europe. The process of integration of (what would become) the core of the System (Europe) and its expansion to a global scale, were coevolving, synchronized processes, that eventually led to a dual-phase transition to ensure compliance of the System with the second law of thermodynamics.

187 The finite-time singularity dynamic (1495-1945) was a highly-optimized dynamic.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Free energy, Performance, Evolvability, Fractal structures.*

Through the finite-time singularity dynamic accompanied by four accelerating cycles, the anarchistic System continuously optimized its performance and evolvability. The finite-time singularity dynamic is the outcome of the application of the second law of thermodynamics.

The singularity dynamic ensured the balanced fulfillment of basic requirements of uneven states in an anarchistic System, indicative of its performance, and the timely adaptation of the order of the System to increasing levels of free energy and tensions in the anarchistic System; a property that is a manifestation of the System's evolvability. Performance especially concerns relatively stable periods, while evolvability especially concerns systemic wars.

Performance and evolvability are related properties: sustained performance (under changing conditions) required timely change, while timely change – evolvability – could only be assured if the performance of the System was maintained.

The increasing levels of free energy that were produced required an acceleration of the frequency of systemic wars, and the deployment of increasing levels of destructive energy, consistent with the second law of thermodynamics; both properties assured that this actually was accomplished.

As I discuss elsewhere, the fractal nature of the System's dynamics and certain structures the System developed during the 1495-1945 period, also point to optimization of the finite-time singularity dynamic.

188 The System's functionality (performance) is determined by the degree to which the actual centrality of states is reflected in the System's order and vice versa.

KEY WORDS *Performance, Centrality of states, Great Power status dynamics, Order, Structural stability, Privileges, Status quo, Powerful-become-more-powerful effect.*

The anarchistic System constitutes a network of issues and states. States – the nodes of this network – differ in their degree of centrality. The centrality of states is determined by their connectivity in the network of issues and states, and their ability to produce and deploy destructive energy. In the contingent domain of the System, the centrality of states – their (Great Power) status – is determined by their power, influence and interests.

The anarchistic System qualifies as an evolving non-equilibrium system, that requires to achieve a certain structural stability through the input of energy. To ensure the collective fulfillment of basic requirements of uneven states in the anarchistic System, states in the System establish (international) orders that provide a certain structural stability.

However, these orders need periodic 'upgrading', when the tensions that are produced and accumulated in the System and undermine its performance, become too high. The production of free energy (tensions) in the anarchistic System is inseparably linked to the intrinsic incompatibility between (increasing) connectivity and security in anarchistic Systems. (Increasing) connectivity drives the production of free energy (tensions), and is closely linked to population size and growth of states in the System.

Because the second law of thermodynamics (also) applies to the free energy that is produced in the System, the free energy (tensions) is periodically put to work (through systemic wars) to implement upgraded orders that allow for a lower energy state of the System, necessary to provide 'new' order – structural stability – that enables the continued fulfillment of basic requirements by states and their populations.

The centrality of nodes and changes in their centrality, that typically occur during relatively stable periods, determine important (evolving) properties of the System; changes in the centrality of nodes also determine the configuration of next upgraded order the System produces and can produce.

The process of realignment of nodes and the configuration of the order itself, can be described as follows (in this description I focus on the deterministic domain of the System; it should be reminded that nodes are represented by states in the contingent domain of the System, and that a node's – state's – centrality determines if it qualify as a Great Power in the System): The second law of thermodynamics applies to the free energy the System produces, and makes that free energy in the System is periodically put to work during critical periods (systemic wars), in order to implement upgraded orders, that allow for a lower energy state of the System.

Nodes (states) in the System interact with each other to ensure the fulfillment of their basic requirements and sufficient energy inputs to ensure their functioning (performance); internally, as well as externally. Nodes in the System have become (increasingly) dependent on each other to achieve this. However, anarchistic systems are intrinsically incompatible: although each interaction between states (nodes) potentially contributes to the fulfillment of their basic requirements, it also results in the production of free energy (tensions); basic requirements of states in anarchistic systems are (to a degree) incompatible, and zero-sum in nature. The free energy that accumulates in the System, eventually causes it to become critical. Anarchistic systems lack other means than 'criticality' (systemic war), to put the free energy (tensions) to work, that eventually percolate the System in the form of underlying vulnerable issue clusters.

During relatively stable periods (international orders, during periods with a low energy state) the centrality of nodes (states) in the System continuously further evolve (change). During critical periods (systemic wars), the actual centrality of nodes – as they have evolved during preceding relatively stable periods – is again aligned with the rules that will apply to their interactions, and that will be embedded in the upgraded order that is collectively designed and implemented.

During critical periods, nodes reposition themselves in the network, in accordance with their centrality, and ensure that the rules that will be adopted – and define the interactions between states in the upgraded order, – support their interests. More central nodes (more powerful and influential states) ensure that the new rules especially promote their interest. If such privileges are not acquired by more central nodes, the upgraded order will not be sufficient stable. During critical periods central nodes enforce these privileges by their ability to deploy superior amounts of destructive energy. Because these privileges especially promote and support central nodes (Great Powers), central nodes have a ('special') interest in maintaining the new status quo (upgraded order). The privileges that are acquired by central nodes contribute to the new order's structural stability, and serve a collective interest.

This mechanism, I name the 'powerful-become-more-powerful effect', makes that nodes with a high centrality (Great Powers), become increasingly central (powerful), by implementing international orders that especially promote their interests (centrality).

189 The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) was a highly-optimized self-organized dynamic.

KEY WORDS *Singularity dynamic, Optimization, Self-organization, Connectivity, Free energy, second law of thermodynamics, Collapse, SIE.*

Starting in 1495, the System produced four accelerating cycles, each cycle consisting of a subcritical period followed by a relatively short period of criticality during which the System produced new upgraded orders through systemic war.

The production of free energy by the System, generated by the singularity dynamic itself, is at the basis of this dynamic. Free energy (in the form of tensions in the contingent domain) is produced by the intrinsic incompatibility inherent to (increasing) connectivity and security in anarchistic systems. Consistent with the second law of thermodynamics, the free energy is periodically put to work to implement upgraded orders that allow for lower energy states. A lower energy state (a relatively stable period) enables the fulfillment of basic requirements by states and their populations, and for their further growth

Connectivity is the driver of the System. When the anarchistic System in 1939 reached the critical connectivity threshold (the singularity in finite time), the anarchistic System collapsed. At that point the System produced infinite amounts of free energy and had become impossible to find a viable order within the anarchistic System, that ensured compliance with the second law of thermodynamics.

The collapse of the anarchistic System caused a dual-phase transition (the fourth systemic war, the Second World War, 1939-1945). Through the dual-phase transition, two dedicated non-anarchistic hierarchies were implemented in the core of the System (Europe), and (simultaneously) a first global order at a global scale of the (now) global anarchistic System. These two inseparable orders ensured – and still ensure – (temporary) compliance with the second law of thermodynamics.

The development and unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) was a highly-optimized dynamic that ensured the continued performance of the System in its ability to fulfill the basic requirements of uneven states in an anarchistic System, and the evolvability of the System; its ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars.

The second law of thermodynamics determined the dynamics of the System. The demands of the second law of thermodynamics led to the implementation of increasing levels of order that temporarily (for the duration of the life span of relatively stable periods of cycles) allowed for lower free energy states in the System.

The increasing levels of order that were implemented through the finite-time singularity dynamic accompanied by four accelerating cycles, were instrumental in a process of social integration and expansion (SIE) in the contingent domain of the System.

190 During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), military organizations and capabilities became increasingly fractal. Fractal structures of military organizations and capabilities, of underlying vulnerable issue clusters, of systemic wars, and of the fractal structures systemic wars carved out as states in the anarchistic System, were closely related coevolving phenomenon.

KEY WORDS *Singularity dynamic, Fractality, Military organizations, Optimization, Fractal systemic wars, Fractal state structures.*

At macro- and micro-level – at state level and level of military units – states try to find the most efficient and effective 'form' of deployment, taking certain conditions and characteristics of respectively states and military organizations and weapon systems into consideration. The fractal structures of states and the fractal organization structures of military organizations - both the outcome of optimization processes shape the tensions and deployments of destructive energy (preceding the outbreak of systemic wars), and vice versa. The characteristics of these dynamics contribute to the forming of vulnerable issue clusters (also) with fractal structures.

The efficient destruction of tensions and issue is accomplished because tensions, issues and deployments of destructive potential become increasingly synonym. The fractal nature of the structure of vulnerable clusters enables the optimized 'distribution' of destructive energy.

191 'Principles of war' optimize the distribution of destructive energy 'shape' why, how, when, and where to fight wars.

KEY WORDS *Principles of war, Risk, Optimization.*

Systemic war and criticality of the anarchistic System are synonyms. At critical points, states deploy and 'counter deploy' destructive energy on a system-wide scale, in efforts to submit other states to one's will and create favorable bargaining positions regarding the design and implementation of upgraded international orders. At the same time as states inflict destruction on other states and their populations, they intensively cooperate with other states in alliances; not only to achieve 'maximal' destruction and hedge risks, but also to (collectively) design and implement favorable upgraded orders. During systemic wars the System consists of a mix of cooperative and conflicting clusters that have fractal structures, I assume.

Risks and the scarcity of resources make states want to complete systemic wars as fast as possible. Systemic wars not only involve the risk of unfavorable outcomes and destruction by other states, but also the risk for internal unbalances as a consequence of the single focus of a state on security requirements during a systemic war. Ignorance of other requirements can cause internal imbalance and even collapse.

War fighting has to be effective and efficient, and requires optimization of the distribution of destructive energy. Optimization is achieved through fractal structures of military organizations and their capabilities, and through the application of principles that guide the deployment of destructive energy. On the battlefield, military organizations follow certain 'principles of war' to achieve maximal effects with minimal risks, using minimal amounts of resources. On the battlefield numerous conflicting demands must be reconciled. On the one hand, the principles of war advocate decisive and offensive action and concentration of force, but on the other hand, economy of force (to ensure sustainability), and security and protection to avoid destruction by the enemy. These principles contradict, and must be reconciled by 'flexibility' and 'unity of command'.

War fighting – in other words – also is a balancing act; a balance must be struck among the achievement of positive battlefield results, a minimum of resources that is deployed to that end, and the risks that are involved in these efforts.

The risks for states, including implementation of unfavorable orders and loss of internal balance and cohesion, and for military units, including destruction and scarcity of resources, put strong pressure on states to end their war efforts as quickly as possible. These requirements also contribute to the optimization of systemic wars.

192 Fractal structures that can be observed in the System and its dynamics are closely related to efficient 'servicing' of the System through various distribution processes, balancing, and adaptation.

KEY WORDS *Fractal structures, Optimization.*

Fractals are ubiquitous in nature and in social processes and structures. It is not exactly clear why and how fractals are formed. I assume (32) that the principle of least free energy selects for these typical structures and that fractal structures point to optimality. As is (often) the case in other systems, I argue that fractal structures are best able to reconcile conflicting requirements and optimize certain properties in a system (network) of nodes that regularly interact.

Bettencourt et al. (11) observe in relation to fractal structures: "Highly complex, self-sustaining structures, whether cells, organisms, cities require close integration of enormous numbers of constituent units that need efficient servicing."

"To accomplish this integration", Bettencourt et al. continue, "life at all scales is sustained by optimized, in some cases space filling, hierarchical branching networks which grow with the size of the organism as uniquely specified approximately self-similar structures… Because these networks, e.g. the vascular systems of animals and plants, determine the rates at which energy is delivered to functional units (cells), they set the pace of physiological processes as scaling functions of the size of the organism." It is the "self-similar nature of resource distribution networks, common to all organisms, that provides the basis for a quantitative, predictive theory of biological structure and dynamics, despite much external variation in appearance and form."

Bettencourt et al. relate these observations not only to biological, but also to social systems: "From this perspective, it is natural to ask whether social organizations also display universal power law scaling for variables reflecting key structural and dynamical characteristics." This line of thought is at the basis of Bettencourt's et al. study of "*Growth, innovation, scaling, and the pace of life in cities*" (10).

West et al. point to the relationship between selection and optimization: "Natural selection has tended to maximize both metabolic capacity, by maximizing the scaling of exchange surface areas, and internal efficiency, by minimizing the scaling of transport distances and times" (75).

I argue that states and the System also require close integration. I assume that fractal structures that can be observed in the System and its dynamics are closely related to efficient servicing of the System through various distribution processes, balancing, and adaptation. These fractal structures are the outcome of a selection process; selection has optimized the System's performance (the ability of the System to balance competing interests) and its evolvability (the System's ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars), as well as various secondary processes.

Besides optimizing the distribution of destructive energy (during systemic wars), fractal structures also contribute to a minimization of the production of free energy (tensions) during relatively stable periods of cycles.

The System adjusted its order four times to allow for a lower energy state. These adjustments were achieved through criticality, through fractal activities (systemic wars) that carved out fractal state structures. The System maximized both the scaling of exchange surface areas and its internal efficiency by minimizing the scaling of transport distances and times. It should be kept in mind that balancing and adaptation is achieved by deploying destructive energy, at all scales. The deployment of destructive energy can be considered a distribution process that can be optimized by following the same logic and making the same trade-offs as other processes of life.

193 Systemic war is about the optimized distribution of destructive energy and of power and influence in the System.

KEY WORDS *Systemic war, Optimization.*

Networks (systems) consisting of regularly interacting nodes (for example, cells in biological systems or states in the System) optimize their dynamics and structures by crystalizing in fractal structures (10), (13), (32), (36), (75). This is especially the case if these interactions concern distribution processes of physical resources, energy, or information. Fractal structures ensure the effectiveness and the efficiency of these distribution processes. At various levels, the System shows fractal dynamics and structures. The system consists of a number states (nodes) that very regularly interact to fulfill their basic requirements. Increasing connectivity of the System contributes to the intensity, frequency, and multitude of interactions between states.

The interactions between states during relatively stable periods and during systemic wars constitute distribution processes. During relatively stable periods, tensions (free energy) are produced and are re-distributed through (for example) non-systemic wars. During (especially) high-connectivity regimes of relatively stable periods tensions crystalize in vulnerable issue clusters that eventually percolate the System, causing the System to become critical and produce systemic wars. During systemic wars the System is in a critical condition, and implements upgraded orders that allow for a lower energy state of the System, consistent with the second law of thermodynamics.

During wars, states distribute destructive energy; at a more abstract level the distribution of destructive energy can be considered the distribution of power and influence. Destructive energy is deployed and distributed through military organizations and capabilities that also have developed fractal structures over time. These fractal structures ensure optimality of the distribution of destructive energy on the battlefield while at the same time, given the fractal structures of military organizations and the capabilities they aim to destroy, minimize their risk of destruction by adversaries.

194 The fractal structures of the System are carved out by fractal systemic war activities.

KEY WORDS *Systemic war, Fractal activity, Fractal structure, Optimization.*

Systemic wars are critical phenomena. As is typical for critical phenomena, systemic wars have fractal structures. They consist of a series of system-wide integrated 'distribution activities' of destructive energy at all levels of the System that unfold during a certain time span. Consistent with the second law of thermodynamics, the System implements upgraded orders through systemic wars that allow for lower energy states of the System. These 'corrective actions' of the second law of thermodynamics are necessary to adjust the System to increasing levels of connectivity and to the increasing levels of free energy (tensions) they imply.

In the contingent domain, systemic wars consist of a small number of campaigns, a larger number of battles, and a very high number of firefights at the lowest level of these wars. Systemic wars can be interpreted as a series of integrated confrontations (distribution processes) between organizational units of different sizes and different levels of organization, and their capabilities. The number and frequency of confrontations depends on the level of organization: the smaller the military unit, the higher its activity and number of confrontations. I argue that the size distribution of confrontation activities in military organizations of different sizes can be best described with a power law. These confrontations are about the distribution of destructive energy, and a power law distribution of the sizes of the fractal structures of these activities points to optimality.

The fractal structures of systemic war activities leave their mark on the organizational and physical structures of the System itself. Through systemic wars, the System implements upgraded orders. The order of the System also manifests itself in the sizes and shapes of states, and in their size distribution.

States are clearly-defined territories and populations states control; their sizes and shapes also define their power, influence, and interests.

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the System developed from a loosely connected collection of hundreds of differing units (in 1495) into a highly integrated System of a relatively low number of standardized states (in 1939). Especially systemic wars were instrumental in this shaping process.

In other words, I argue that the fractal nature of systemic wars explains why the size distribution of states in the System could increasingly be better described by a power law size distribution (that implies fractality of the System's structures). I assume that the fractal nature of systemic wars and the fractal structures of states in the System coevolved; fractal systemic war activities carved out fractal state-structures in the System, and vice versa.

195 Various fractal structures that can be observed in the System are closely related.

KEY WORDS *Fractal structures, Collective optimization.*

The deployment of destructive energy can be considered a distribution process that can, in principle, be optimized following the same logic and trade-offs as other distribution processes of life. The organizational fractality of military units and the fractality of military activities (military operations) contribute(d) to the optimized distribution of destructive energy by military organizations, by maximizing the scaling of exchange surface areas of destructive energy, and simultaneously minimizing the scaling of transport distances and times. Fractal structures and processes ensure(d) effective and efficient distribution of destructive energy to reestablish balance and order in the System.

Fractal military organizations and fractal war activities that optimize the distribution of destructive energy during systemic wars, fractal state-structures that minimize the production of free energy (tensions) during relatively stable periods, and optimize (re)distribution of power and influence during systemic wars, and fractal casualty dynamics, are related phenomena, produced by the second law of thermodynamics.

196 Fractal structures and dynamics – at various levels of the System – optimize the performance and evolvability of the System.

FRACTAL *structures, Optimization, Performance, Evolvability.*

The purpose of systemic wars is to implement upgraded orders that allow for a lower energy state of the System – 'new' relatively stable periods – consistent with the second law of thermodynamics. Systemic wars are manifestations of criticality of the System. The fractal nature of systemic wars (of the System's structures and dynamics during critical periods) ensures the optimized distribution of destructive energy in the System by states, consistent with their actual power and influence.

Upgraded orders with fractal properties could (and can) best meet the (competing) requirements of uneven states in an anarchistic System to fulfill their basic requirements, and survive. Fractal state-structures minimize(d) the build-up of free energy (tensions) during relatively stable periods, ensuring an optimized ability of the anarchistic System to balance the fulfillment of basic requirements by uneven states. Fractality of dynamics and structures contributed to the simultaneous optimization of the System's performance and evolvability.

197 The System needs small states that function as buffers between Great Powers to optimize the System's performance.

KEY WORDS *Fractal structures, Optimization, Function of smal(ler) states.*

In the contingent domain, Great Powers recognize that smaller states fulfill an important role in balancing the System, and can be helpful in preventing the production of free energy (tensions) and in maintaining the status quo. Morgenthau explains how a strong focus on preservation and expansion of power by states in an anarchistic system contributes to a certain balance of power, of which small nations are an integral part, to ensure the system's functioning ((43), see also: (30)).

Small states can form buffers between rival Great Powers. Belgium, a small state, was created by the Great Powers (43) with the aim of structurally decreasing tensions that tended to build up in the System, and that could threaten the status quo embedded in the latest upgraded order (1815, Congress of Vienna). Morgenthau explains these considerations as follows: "The outstanding example of a buffer state owing its existence to the balance of power is Belgium from the beginning of its history as an independent state in 1831 to the Second World War". Belgium was established by the Congress of Vienna to improve the balance of power in Europe and to prevent new destabilizing tensions that tended to emerge in the System. Belgium can be considered a correction of the international order that was produced by the third systemic war (the French Revolutionary and Napoleonic Wars, 1792-1815).

Morgenthau's and the Realist School's reasoning shows how selfish considerations of states contribute to the emergence and conservation of small states.

I argue that the addition of Belgium to the System as a new state, contributed to the degree of fractality of the anarchistic System and, by doing so, improved the ability of the System to further optimize its balancing function.

198 The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) constitutes a 'synchronized multi-level optimization process'.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Optimization, Multi-level, Performance, Evolvability, Chaotic dynamics, Basic requirements, International orders, Systemic wars, Destruction Power, Influence.*

The singularity dynamic simultaneously accomplished two 'objectives': (1) optimal performance, the balanced fulfillment of basic requirements by uneven states in an anarchistic system and (2) optimal evolvability, the periodic reorganization (through systemic wars) of the order of the System. Performance concerns relatively stable periods (international orders; evolvability concerns critical periods (systemic wars).

Given the constant (connectivity) growth of the System, evolvability (periodic adjustment) is a prerequisite of the System's performance. However, the opposite is also true: optimal performance is a prerequisite for optimal evolvability.

Different dynamics and mechanisms, at different 'levels' of the System contribute to its overall performance and evolvability.

1 ***Chaotic non-systemic war dynamics ensure the efficient development of the System***

Chaotic war dynamics are more constrained, and allow for the crystallization of underlying vulnerable issue clusters with fractal structures that eventually result in the System's criticality. Criticality is periodically 'required' for the design and implementation of upgraded orders in the anarchistic System that allow for a lower energy state (as demanded by the second law of thermodynamics). The impact of abnormal war dynamics on the dynamics and development and unfolding of the singularity dynamic (1495-1945) confirm this assumption.

2 ***Optimal fulfillment of basic requirements by uneven states in an anarchistic System require international orders that reflect actual power and influence positions of states***

This dynamic concerns the efficiency and effectiveness of international orders to perform their function. International orders are produced through systemic wars. They perform a clear function, which is to ensure balanced fulfillment of the basic requirements of uneven states that must compete for scarce resources in an anarchistic system, while at the same time becoming increasingly dependent on each other. Over time (during their life span), international orders become increasingly dysfunctional and require at a certain stage adjustment of their organizational structure (to ensure compliance with the second law of thermodynamics). Optimality of international orders is achieved through the process by which international orders are designed and implemented. This process is an integral part of systemic wars.

3 ***A critical condition (criticality of the System) ensures the efficient destruction of issues and tensions in the System, as well the efficient design and implementation of upgraded international orders***
Criticality enables system-wide communication, coordination and planning, because it implies (by definition) a correlation length of 'one'.

Criticality concerns the evolvability of the System; systemic wars are equivalent with – manifestations of – criticality of the System. The System lacks mechanisms other than systemic war to reorganize itself and adjust its order to changed conditions (as required by the second law of thermodynamics); systemic wars are highly instrumental in restoring order. Periodic change is required to ensure the functionality and survival of states.

Systemic wars are highly optimized phenomena. War fighting and alliance dynamics are integral activities of systemic wars, not only for the destruction of dysfunctional issues and tensions, but also for states to position themselves in bargaining processes that accompany the design and implementation of upgraded orders.

War fighting itself also is a highly optimized 'activity' that is guided by principles – 'principles of war' – that ensure its efficiency and effectiveness. By employing these principles commanders of military units are urged to strike a balance between the deployment of decisive military power at the right time and place, and economic use of force, to avoid depletion and shortages.

The risks for states (e.g., losing internal balance and cohesion) and for military units (e.g., running out of resources and being destroyed) put strong pressure on states to end wars as quickly as possible. These requirements also contribute to the efficiencies of systemic wars.

4 ***Compliance of the System with the demands of the second law of thermodynamics results in highly efficient energy transfers; the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) is a manifestation of this 'mechanism'***
The singularity dynamic is a punctuated equilibrium dynamic that pushes the System to a finite-time singularity manifested by a phase transition. The finite-times singularity dynamic the System produced is a product of the second law of thermodynamics, which applies to free energy that is produced by the anarchistic System.

199 Limitations to the 'span of control' contributes to the fractality of military organizations and capabilities.

KEY WORDS *Fractal structures, Optimization, Span of Control.*

Optimal deployment of destructive energy requires the processing of information by military organizations, to identify (high-value) targets, decide how these targets must be engaged (with what capabilities), and when and where this should happen; military organizations must ensure and balance the accomplishment of their mission (tasks assigned to these units), their survival, and the minimal use of resources. To that end, information must be gathered and processed by integrative structures of military organizations, decisions must be communicated, and effects must be evaluated. A military organization can be considered a network of (parallel) information processing 'nodes'.

These nodes (commanders of military units and their headquarters, etc.) have, however, certain limitations in their information processing capabilities (quantitative as well as qualitative), referred to as 'span of control'. The span of control of a node (commander, headquarter) depends on various conditions but is considered to be around six; six refers to the number of subunits (including staff elements) a unit typically consists of.

If the span of control is exceeded, information processing becomes problematic, affecting the effectiveness and efficiency of military organizations. Underuse also leads to inefficiencies. The span of control contributes to the formation of fractal organizational structures in military organizations and capabilities.

13 FREE ENERGY AND ENERGY TRANSFER.

200 The System is a non-equilibrium system.

KEY WORDS *High-connectivity regime, second law of thermodynamics, Non-equilibrium.*

States and the System were constantly subject to energy input from increasing connectivity and population growth, and energy output through energy releases. Before being released through systemic wars, during high-connectivity regimes of relatively stable periods tensions (free energy) crystalized in vulnerable issue clusters. When these vulnerable issue clusters eventually percolated the System, the System became critical and energy was put to work through systemic wars to implement upgraded orders, that allowed for a lower energy state of the anarchistic System, consistent with the second law of thermodynamics. These energy processes, in combination with the laws and principles that apply to these processes, resulted in a self-organized finite-time singularity dynamic, accompanied by four accelerating cycles. The singularity dynamic determined and shaped the production, distribution, and use of energy (tensions), and ensured the continued performance of the System (see also: (60)).

201 The System's energy state during successive relative stable periods, its metastabilty, consistently increased.

KEY WORDS *Energy, Metastability.*

At the same time as both the amounts of free energy (tensions) the System produced during the unfolding of the finite-time singularity dynamic (1495-1945), and the frequencies of successive systemic wars accelerated, the System also became more robust and stable at the same time, implying that the System was increasingly able to absorb perturbations (without generating non-systemic release events) and store free energy as unresolved issues and tensions. These simultaneous and related developments – the storage of increasing amounts of free energy (tensions), and a decrease in non-systemic release events (non-systemic wars) – imply that during successive relatively stable periods, the System was in increasingly higher energy states, and was increasingly metastable.

202 **During high-connectivity regimes, increasing connectivity of the network of issues and states produced increasing local stabilities; these increasing local stabilities functioned as thresholds.**

KEY WORDS *High-connectivity regime, Local stability, Free energy release deficit, Thresholds, Crystallization, Systemic war.*

During high-connectivity regimes of relatively stable periods (1495-1945), increasing connectivity of the network of issues and states contributed to local stability of states, resulting in 'local' stabilities in the System. These local stabilities caused a decreases in the sizes of non-systemic wars (non-systemic energy releases), and instead of being released, tensions (unresolved issues) were 'stored' in the System, formed a free energy release deficit, and crystallized in vulnerable issue clusters with fractal structures. The degree of local stability determined the System's thresholds: its ability to store free energy (tensions from unresolved issues) and to endure higher energy states without generating non-systemic wars.

203 **As a consequence of the intense rivalry between Britain and France (during the first exceptional period, 1657-1763), the 'driving' of the System became too strong while the local stability thresholds of the System were not strong enough to allow the System to relax in a metastable configuration. The intense rivalry between Britain and France had neutralized a third 'balancing' degree of freedom, causing the external drive to completely dominate the System's behavior.**

KEY WORDS *Exceptional period, Rivalry, High-connectivity regime, Chaotic non-systemic war dynamics, Non-chaotic non-systemic war dynamics, Inefficiencies, Hyper-excited war dynamics.*

The buildup of free energy (tensions) in the System through growth of the network of issues and tensions needs to be slow, to allow the System to become critical, produce a systemic war, and implement an upgraded order that enables a lower energy state of the System. A strong drive will not allow the System to 'relax' and store tensions, that can crystallize in vulnerable issue clusters; the storage and crystallization of unreleased tensions is a prerequisite for the System to eventually become critical (when vulnerable issue clusters percolate the System), produce a systemic war, and implement an upgraded order that enables a lower energy state of the System.

During the exceptional period (1657-1763), when the balancing effect of a third degree of freedom was neutralized as a consequence of the intense rivalry between Britain and France, the drive of the System was temporarily too high and the System became hyper-excited; as a consequence, the System produced a series of exceptionally large and intense non-systemic wars.

The strong drive hindered the intrinsic chaotic properties of the System to control the non-systemic war dynamics, and the dynamics of the System became entirely dominated by the rivalry between Britain and France.

The inability to relax in a metastable configuration did not allow the System to experience a relatively stable period, and 'establish' a high-connectivity regime, necessary for the storage of free energy (tensions), and the crystallization of tensions in vulnerable issue clusters with fractal structures. Such a storage and crystallization process is – as I explained – a precondition for the System to become critical, produce a systemic war, and be able to implement an upgraded order that enables a lower energy of the System.

Thus, chaotic non-systemic war dynamics (implying a least three degrees of freedom) provide the necessary 'internal control' for the anarchistic System to become critical, and be able to upgrade its order. Chaotic non-systemic war dynamics are for that reason closely related to – necessary for – the evolvability and continued performance of the anarchistic System.

204 Through the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the System optimized its performance and evolvability, and was able to strike an optimal balance between order and change.

KEY WORDS *Singularity dynamic, Cycles, Performance, Evolvability, Optimum.*

'Optimized evolvability' can be observed at two levels of the System. Optimized evolvability' can be observed at the level of the singularity dynamic (1495–1945), and at the level of cycles; the optimization' of both dynamics ('levels') is closely related. During the unfolding of the singularity dynamic a selection process concerning the System's units (states), and a co-evolutionary dynamic concerning states and successive international orders, ensured that the System "found good dynamical behavior" (as Kauffman puts it), between a certain level of order and disorder, where the performance and evolvability of the System, were optimized (36). Performance refers to the ability of the System to ensure the balanced fulfillment of basic requirements of uneven states in the anarchistic System; evolvability refers to the System's ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars; both properties are closely related.

During systemic wars, when the System is in a critical condition, the System also ensures an optimal mix between order and disorder, enabling uneven states to design and implement a new viable order that better meets the changed conditions in/of the System.

The ability of the anarchistic system to find its optimal point of 'evolvability' is vital for the survival of states and international orders that are constantly confronted with change.

205 The structural stability of international orders determined how much destructive energy had to be deployed during subsequent systemic wars to enable the implementation of upgraded orders.

KEY WORDS *Structural stability, International orders, Destructive energy, Upgraded orders, Singularity dynamic, Energy storage, Crystallization, Criticality.*

During the 1495-1945 period the System produced a finite-time singularity dynamic accompanied by four accelerating cycles; each cycle consisting of a relatively stable period (international order) followed by a systemic war. An international order – the order of a relatively stable period – is the outcome of the preceding systemic war.

The second law of thermodynamics was (and still is) responsible for this dynamic: during systemic wars free energy (tensions) are put to work to implement upgraded orders in the System that allow for lower energy states. Such a 'lower energy state' enables the implementation of an upgraded order, and 'new' structural stability. Structural stability is a prerequisite for states (in the contingent domain) to be able to fulfill their basic requirements.

Because the anarchistic System produced accelerating amounts of free energy (tensions) during the unfolding of the finite-time singularity dynamic (1495-1945), upgraded orders had to be implemented at an accelerating pace. Each successive international order was – and had to be – more stable to contain the higher levels of free energy (tension) in the System. The fact that the Great Power status dynamics of the System decreased (linearly) in Europe during successive cycles, state structures (their sizes) became more fractal, and organizational arrangements of successive international orders became more comprehensive, are indicative for the increasing structural stability of the System. At the same time, the increasing robustness of the anarchistic System ensured that free energy (tensions) that was produced, could be better 'stored', without resulting in non-systemic release events. Instead of being released, these tensions crystallized into growing vulnerable issue clusters that eventually percolated the System and caused it to become critical and produce systemic wars.

The fact that successive relatively stable periods became more stable and robust, means that on the one hand they could increasingly better 'cope' with higher tension levels, on the other hand, that increasingly more energy input was required (during systemic wars) to destroy 'old' more tightly connected orders, and implement upgrades. The storage capacity (of tensions) of international orders, and the free energy required to upgraded these (more stable) orders, are two sides of the same coin.

206 Abnormal war dynamics during the first exceptional period (1657-1763) caused inefficiencies in the unfolding of the finite-time singularity dynamic (1495-1945).

KEY WORDS *Exceptional period, Abnormal war dynamics, High-connectivity regime, Criticality, Inefficiencies.*

I argue that relatively stable periods (international orders) are characterized by two regimes, namely a low- and high-connectivity regime, respectively, separated by a tipping point. I also argued that by default, non-systemic wars are chaotic in nature, implying that they are deterministic but also intrinsically unpredictable. During the first exceptional period (1657–1763) chaotic war dynamics were temporarily 'downgraded' to periodic dynamics as a consequence of the intense rivalry between Britain and France. The System experienced a second exceptional period (1953-1989) as a consequence of the intense rivalry between the United States and the Soviet Union, and the respective hierarchies they controlled (in Europe).

During the first exceptional period (1657-1763), the number of degrees of freedom (n) of the System was temporarily reduced from at least three, producing chaotic dynamics, to two, thereby producing more regular periodic hyperactive war dynamics. Despite the system-wide size of a number of non-systemic wars during the first exceptional period, these wars did not qualify as systemic wars. Instead, they were merely very large non-systemic wars that were not kept in check by a third balancing degree of freedom.

The abnormal war dynamics during the exceptional period show that chaotic conditions (in combination with a high-connectivity regime) are a prerequisite for the development of vulnerable issue clusters with fractal structures, as well as for the development of a critical condition (point). Criticality and systemic wars are synonyms, and criticality (systemic war) is a prerequisite for the upgrading of orders in the System: Criticality enables system-wide communication, coordination, and planning necessary for the collective system-wide design and implementation of upgraded orders.

The moment the intense rivalry between Britain and France was resolved to the advantage of Britain in 1763, the System resumed chaotic war dynamics. The second relatively stable period (international order) reached its tipping point in 1774. From that moment onwards, the average size of non-systemic wars the System produced decreased as a consequence of local stability effects caused by the high connectivity of the issue network. The next systemic war was produced in 1792 (the second systemic war, the French Revolutionary and Napoleonic Wars, 1792-1815).

The abnormal war dynamics, however, impacted on the development of the otherwise timely and highly efficient finite-time singularity dynamic.

I argue that the abnormal war dynamics during the first exceptional period produced two effects: (1) a delay in the development toward criticality, causing a lengthening of the life span of the second relatively stable period, and (2) the deployment by states of exceptional high levels of destructive energy during non-systemic wars. I argue that both effects are indicative for the inefficiencies non-chaotic war dynamics caused.

207 Free energy releases follow the path of least resistance, an energy principle that also is related to the second law of thermodynamics.

KEY WORDS *Free energy, second law of thermodynamics, Path of least resistance, Robustness, MAD, Contingent domain.*

During the second exceptional period (the Cold War, 1953-1989) tensions (free energy) that built up in the System (especially in Europe) as a consequence of the intense rivalry between the United States and the Soviet Union, and their respective hierarchies, could not be released in Europe because of Europe's infinite robustness (a network property) and the deadlock (I refer to 'mutual assured destruction', MAD in nuclear-strategy terminology) the rivalry had resulted in.

Instead of being released in Europe free energy – as far as it was and could be released – was put to work outside Europe.

The high connectivity of Europe, and the infinite robustness this implied, prevented non-systemic wars from breaking out in Europe. However, the connectivity of the global system outside Europe was still insufficient to accomplish such an effect; the risks for escalation could also be better controlled outside Europe. Tensions produced in Europe between both super powers and their respective hierarchies were projected outside Europe, where they found suitable issues in the contingent domain and caused a number of non-systemic wars. Although free energy was now and then released outside Europe, the non-systemic wars the System produced (and could produce) during the period 1953-1989, were very subdued.

I argue that such a 'displacement' of tensions, was a consequence the intense rivalry between the United States and the Soviet Union that above all played out in Europe. The connectivity of both hierarchies in Europe, and the MAD-deadlock, did not allow for free energy releases in Europe itself. Free energy was pushed to parts of the global System that still allowed for release events. The displacement of free energy is also related to the second law of thermodynamics; free energy releases follow a path of least resistance.

208 A number of factors determine the path of least resistance of free energy releases in the System.

KEY WORDS *second law of thermodynamics, Path of least resistance, Lower energy state, Systemic wars, Non-systemic wars, Factors, Conditions.*

The path of least resistance of energy releases is related to the second law of thermodynamics, and is also, along with the principle that free energy will be put to work in order to implement upgraded orders that allow for a lower energy state of the System, a 'energy principle' that has a significant impact on the dynamics and development of the System, including in the contingent domain. This principle applies to both categories of war: systemic and non-systemic.

The path of least resistance determines how a *systemic* war unfolds, given the precise structure of vulnerable issue clusters that at a certain point reach a percolation condition, are triggered and set in motion a series of cascades. The vulnerable issue clusters are contingent crystallizations of (unresolved) issues and tensions. Despite the deterministic nature of energy releases and their path, the highly susceptible condition of the System at criticality and its sensitivity for even very small perturbations make this a highly unpredictable process.

The path of least resistance principle also impacts the location and timing of *non-systemic* wars, and to what extent a localized war can escalate. Given the factors and conditions that determine the path of least resistance, the path is a dynamic property and constantly changes as a consequence of the factors that influence local energy states.

A number of factors and conditions define this path; including:

1) The location, size (number of participating states), participants, duration, and severity of preceding non-systemic wars. Non-systemic wars are input for the System and determine and shape (at least in some respects) a next non-systemic release.

2) The connectivity of the System; a property of the System that determines the sizes and frequency of non-systemic release events. A closer look at the average sizes and frequencies of low- and high-connectivity regimes of war clusters during successive relatively stable periods shows that average sizes of non-systemic wars and their frequencies during successive clusters are related properties. The development of these properties during the first three relatively stable periods suggests that, although overall energy releases during high-connectivity regimes always decreased and halted shortly before the System produced systemic wars, lower average sizes of non-systemic wars during high-connectivity regimes went hand-in-hand with higher frequencies; lower average sizes seemed to be partially compensated by higher frequencies.

3) The distribution of energy in the network of vulnerable issues and related tensions.

4) The number of degrees of freedom of the System that determines the nature of non-systemic war dynamics (chaotic or periodic), and to what degree tensions and energy releases can be constrained.

5) Contingent conditions and variables that determine when and where local issue clusters are triggered, and produce non-systemic energy releasing wars.

209 During successive cycles of the first finite-time singularity dynamic (1495-1945), the anarchistic System increasingly released free energy during systemic wars instead of non-systemic wars; the release ratio shifted 'in favor' of systemic wars.

KEY WORDS *Singularity dynamic, Energy release, Destructive energy, Severities of wars, Release ratio.*

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the energy release distribution during successive cycles shifted in favor of systemic wars. I define the ratio of the severity of the systemic war of a cycle and the total severity of all wars during the cycle, as the release ratio of a cycle. I consider the severities of wars indicative for the destructive energy that is deployed during wars, for the amount of free energy that is released.

The change in the energy release distribution can be attributed to the increasing robustness of successive relatively stable periods of cycles. Ultimately, when during the fourth relatively stable period (1918-1939), the anarchistic System became completely robust, the release ratio became one, meaning that all energy was (and only could be) released during the fourth systemic war (the Second World War, 1939-1945).

However, the development of the release ratio shows a significant distortion during the second cycle (1648-1815).

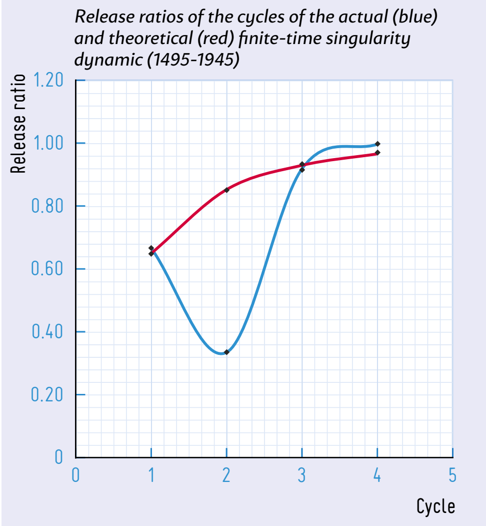
Release ratios of the actual and theoretical finite-time singularity dynamic (1495-1945)

		Actual FTS (Severity in BCD)			Theoretical FTS (Severity in BCD)		
Cycle	Period	Severity systemic war	Total severity	Ratio	Severity systemic war	Total severity	Ratio
1	1495-1648	1,971,000	2,976,000	0.66	1,971,000	3,036,000	0.65
2	1648-1815	2,532,000	7,550,300	0.34	4,900,000	5,750,000	0.85
3	1815-1918	7,734,300	8,425,080	0.92	8,100,000	8,720,000	0.93
4	1918-1945	12,948,300	13,003,300	1.00	11,100,000	11,500,000	0,97

Table 95 *This table shows the release ratios of successive cycles of the actual and theoretical finite-time singularity which was accompanied by four accelerating cycles (1495-1945).*

If the ratios of the actual and theoretical finite-time singularity are plotted in a graph, the (just mentioned) distortion during the second cycle (1648-1815) is visible.

Figure 116
This table shows the release ratios of the successive cycles of the actual (in blue) and theoretical (in red) finite-time singularity that was accompanied by four accelerating cycles (1495-1945). The distortion caused by the first exceptional period is clearly visible (1657-1763).



During the period 1657-1763 – I designated as the first exceptional period – the non-systemic war dynamics of the System were temporarily non-chaotic in nature, and produced a series of extreme non-systemic wars (in terms of size and severities), because the System during that specific period lacked a third – balancing – degree of freedom that would have produced chaotic non-systemic war dynamics.

The abnormal non-systemic war dynamics during the exceptional period (during the second cycle) had a number of effects, including: (1) an 'over-production' of free energy (tensions), resulting in a series of 'extreme' non-systemic wars, (2) a shift in the energy release distribution of the System, and (3) a delay in the unfolding of the second cycle.

1 ***Over-production of free energy***
The abnormal non-systemic war dynamics resulted in an increase of 0,92 percent of the total severity of the cycle (0,92% of the population size at the start of the second systemic war.

2 ***A distortion in the release ratio of the second cycle***
Significantly more energy was released through non-systemic wars during the relatively stable period of the second cycle), than would be the case if the non-systemic war dynamics were not disturbed, as the theoretical model of the first finite-time singularity dynamic suggests. It seems that the increase in the energy-release through non-systemic wars, was (at least to a degree) 'compensated' by a significant lower release during the second systemic war (the French Revolutionary and Napoleonic Wars, 1792-1815); the actual release ratio was 0,34 instead of 0,85 (theoretical).

3 ***A delay in the unfolding of the second cycle***
This delay was about 13 years as this study suggests.

210 States and societies in the System produced increasingly radical ideologies that contributed to the ability of states to produce increasing amounts of destructive energy, and ensured the development and unfolding of the finite-time singularity.

KEY WORDS *Free energy, Ideologies, Destructive energy, Singularity dynamic, Justification, Mass mobilization, Crystallization, Cause, Purpose, second law of thermodynamics.*

The increasing amounts of free energy (tensions) that were required at accelerating rates to sustain the development and unfolding of the finite-time singularity dynamic (1495-1945), required mass mobilization of societies of states for the production and deployment of sufficient amounts of destructive energy.

Ideologies, (nationalism, communism, and fascism) were instrumental for states to accomplish mass mobilizations of their societies.

Ideologies – and increasing radicalization (of the ideologies themselves, and their effects) – however served more (but related) purposes, including (besides justification for mass mobilization):

1 ***(Further) reinforcing – 'fueling' – increasing levels of tensions between states through the security dilemma, by linking ideologies of states to their survival, and presenting competing ideologies (of other states) as existential threats***

2 ***By providing crystallization points – issues (related to competing ideologies) – that provided new 'content' to interacting self-fulfilling prophecies between states***

The fourth systemic war (the Second World War, 1939-1945) required 'infinite' amounts of destructive energy, to achieve the effects as 'demanded' by the second law of thermodynamics. These amounts of destructive energy could only be produced and deployed if all domains and resources of states and societies were mobilized and deployed. This – efforts on such a scale – could only be accomplished with ideologies that provided a clear cause and purpose, that were directly linked to the survival of states and their societies.

211 A case study: Exploiting a 'new' path of least resistance.

KEY WORDS *second law of thermodynamics, Path of least resistance , Populations, International order, Exploitation Internet and social media, Multiplier effect.*

The hybrid form of current conflicts in the Middle East could well be a preview to future – larger scale – conflicts in the System; I point to the emergence of radical communities that apply terrorist methods. These radical communities can be considered a response to failing states; to the inability of states to adequately fulfill and 'protect' the basic requirements of their populations. Religious (inspired) ideas are used to offer an alternative, such an approach is now 'tested'.

Radical communities exploit discontent and (further) exposes the weakness of states, not only regionally, by superimposing an alternative organizational structure, but also by leveraging the Internet and social media. Furthermore, radical communities contribute to inter-state rivalries (rivalry between for example the United States and Russia), by involving Great Powers in their conflict.

The modus operandi of these radical communities has the following characteristics:

1 ***Providing a 'religious' alternative for the state***
Exploiting weaknesses of states, by providing an alternative structures and legislation based on radical ideologies.

2 ***Undermining the international order***
Discrediting the international order (of which states are an integral part), and promoting an alternative; the alternative radical communities provide will and can never be accepted by the current order, which makes the international order a 'target'.

3 ***Escalate the conflict***
Involving other states, to cause further destabilization.

4 ***Exploit the Internet and social media to recruit and direct terrorist***
Exploit the Internet and social media to recruit 'fighters' in other states to conduct acts of terror, and start in those countries a 'war from within', that undermines the legitimacy of these states, and provokes these states to join the war in the Middle East.

5 ***Exploit the Internet and social media to achieve a multiplier effect***
Create franchises, that act as multipliers.

Radical communities create 'world-wide' communities, and uses this network of communities to undermine states and the international order, by exploiting the Internet, social media and global mobility; radical communities try to 'organize' a self-reinforcing dynamic, in which rivalries between states, inter-state wars, social unrest in states (at a global scale), and responses of states cause wide-spread tensions, that are than put to work to further reinforce this dynamic. To develop sufficient momentum and be successful at a global (a significant) scale, a certain critical size of the radical network (and its dynamics) is required. These radical communities cannot achieve, however, the fact that the System becomes critical at a global scale around 2020, a process to which radical communities contribute, will provide new opportunities for them.

The modus operandi of radical communities – that also will further evolve – will be used in the future, for the very simple reason that free energy can be put to work efficiently, and by exploiting 'new' paths of least resistant for the (effective) deployment of destructive energy.

212 The participation of Great Powers in non-systemic wars involving at least two Great Powers can be approximated with a Zipfian distribution.

KEY WORDS *Participation, Great Powers, Non-systemic wars, Zipfian distribution.*

Below table specifies the involvement of Great Powers in non-systemic wars (expansion wars excluded) that involved at least two Great Powers during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945).

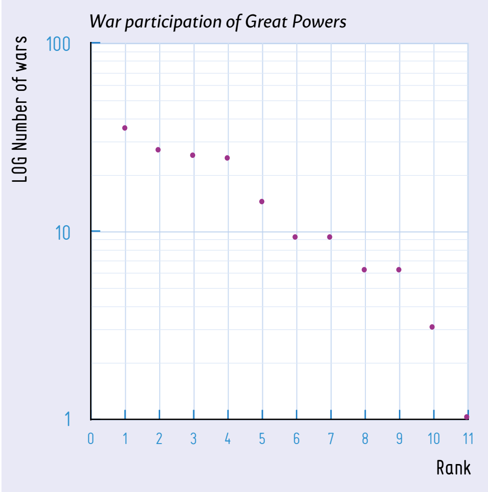
In total this concerns 63 non-systemic wars.

Rank order of Great Power participation in non-systemic wars (expansion wars excluded), at least involving two Great Powers (Number of wars is 63, based on Levy (38))

Rank	Great Power	Number of wars
1	France	35
2	Austrian Hapsburg/Austria/Austria-Hungary	26
3	England/Great Britain	25
4	Spain	24
5	Ottoman Empire	14
6	United Hapsburg	9
7	Russia/Soviet Union	9
8	The Netherlands	6
9	Prussia/Germany/West Germany	6
10	Sweden	3
11	Italy	1

Table 96 *This table shows the number of non-systemic wars (expansion wars excluded) between at least two Great Powers, Great Powers participated in during the period (1495-1945).*

Figure 117
Plot of the number of non-systemic wars (expansion wars excluded) between at least two Great Powers, Great Powers participated in during the period (1495-1945); the numbers refer to Great Powers (see above table). The distribution approximates a Zipfian distribution.



Further research is required to determine the origin of the Zipfian distribution, and if the distribution is related to the (normally) chaotic nature of non-systemic war dynamics.

213 The distribution of the duration of non-systemic wars (expansion wars excluded) involving at least two Great Powers approximates a Zipfian distribution.

KEY WORDS *Duration, Non-systemic wars, Zipfian distribution.*

The cumulative distribution of the durations of the same (63) non-systemic wars that produced a rank order for participating Great Powers that approximates a Zipfian distribution (see previous statement), also seems to approximate such a type of distribution.

Distribution of the duration of non-systemic wars (expansion wars excluded) involving at least two Great Powers (1495-1945), n = 63. Based on data Levy (38)

0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	17-18	19-20	21-22
8	8	8	11	2	5	5	3	1	3	2	2	1	1	1	1	1

Table 97 *This table shows the distribution of the duration of 63 non-systemic wars during the 1495-1945 period, that involved at least two Great Powers. The figures in the second row (0-1, 1-2, etc.) concern the brackets I introduced to determine the duration distribution: 1-2 stands for example for wars with a duration of 1 until 2 years.*

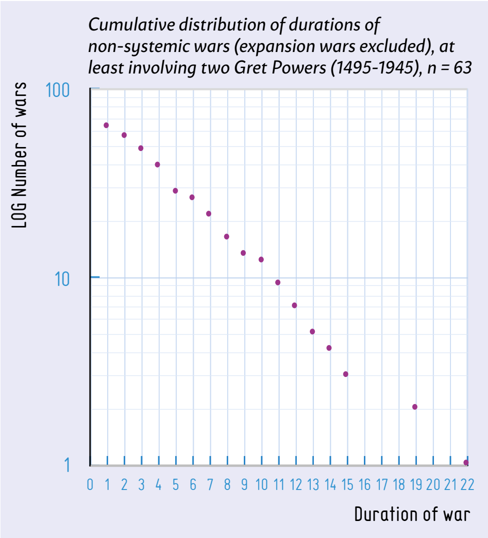


Figure 118
This figure shows the cumulative distribution of the duration of 63 non-systemic wars during the 1495-1945 period, that involved at least two Great Powers. The figures in the x-axis concern the duration of wars. 63 wars had a duration of at least 0-1 year, 55 wars had a duration of at least 1 year, etc. Data based on Levy (38)

Further research is required to determine the origin of this Zipfian distribution, and if the distribution is related to the (normally) chaotic nature of non-systemic war dynamics.

14 DETERMINISTIC AND CONTINGENT DOMAINS

214 A deterministic and a contingent domain can be distinguished in the System.

KEY WORDS *Deterministic domain, Contingent domain, Deterministic laws, Deterministic principles.*

This study shows that two domains, a contingent and a deterministic domain, can be distinguished in the anarchistic System, where respectively deterministic and contingent dynamics play out. This is above all an analytical distinction. Both domains interact with and 'feed' on each other.

Until now, we were not aware of the existence of such a deterministic domain in the System, nor of the fact that deterministic laws determine and shape the dynamics and development of the contingent domain of the System, where contingency also plays a significant role.

The contingent domain is where events as we experience them play out, and concerns the dynamics that historians and social scientists typically focus on while remaining unaware of the existence of deterministic laws.

However not only impacts the deterministic domain (like the second law of thermodynamics, the number of degrees of freedom in the System that determines the nature of the System's non-systemic war dynamics, and the connectivity/local stability effect) on the contingent dynamics of the System; contingent dynamics also impact on the deterministic laws and rules that apply: the intensity between rivalries of Great Power, for example, determines the number of degrees of freedom in the System, and the nature of its non-systemic war dynamics. The first exceptional period (1657-1763) shows the interactions between both domains, in both directions.

I sometimes refer to the dynamics that play out in the deterministic domain as the 'underlying dynamics of the network *of* the System'. The deterministic domain and accompanying dynamics determine and shape some very significant properties of the contingent dynamics *on* the network. The deterministic domain defines a set of parameters for the contingent domain and defines how the dynamics *on* the network can play out. The deterministic domain defines the latitude for contingent dynamics.

In the table below, I specify some deterministic and contingent properties of systemic wars.

Deterministic and contingent properties of systemic wars	
Deterministic properties	Contingent properties
Start time, duration, amount of free energy that has to be put to work to implement an upgraded order, direction of development towards increased order.	Why or what social issues the war is fought for, what events trigger the war, how the war is fought.

Table 98 *This table specifies deterministic and contingent properties of systemic wars.*

The deterministic domain and its dynamics determine, for example, the start and end times of systemic wars. Systemic wars and their properties were produced by a finite-time singularity accompanied by four accelerating cycles (1495-1945) that 'unavoidably' produced a phase transition when the anarchistic System in 1939 the critical connectivity threshold; the finite-time singularity dynamic is deterministic in nature, and is the outcome of the 'unnegotiable' application of the second law of thermodynamics. The finite-time singularity dynamic was in other words, a manifestation of the application of second law of thermodynamics to the free energy the anarchistic System produced; the second law of thermodynamics for example determined when free energy had to be put to work to implement upgraded orders that allowed for a lower free energy state of the System.

Deterministic laws not only determine the key characteristics of systemic wars, but also define the direction of development of the anarchistic System towards increasing levels of order to ensure lower energy states of the System. Deterministic laws do not, however, determine what kind of political system is implemented in the contingent domain of the System, as long as the deterministic requirements of the second law of thermodynamics for a lower energy state are obeyed. The 'democratic/capitalist' (Western) non-anarchistic dedicated hierarchy and the 'authoritative/planned economy' (eastern) dedicated hierarchy that were through the fourth systemic war (the Second World War, 1939-1945) implemented, both initially met the deterministic requirements of the second law of thermodynamics. Despite their 'internal' differences, both non-anarchistic hierarchies, contributed to a decreases in the total amount of free energy that was produced by the anarchistic System following the Second World War (1939-1945).

Not only do the second law of thermodynamics and its accompanying energy principles apply to the System, but also certain principles and mechanisms that have the character of 'laws'. They include the following principles and mechanisms: (1) increasing connectivity and security are incompatible in anarchistic systems, and cause the production of free energy (to which the second law of thermodynamics applies), (2) population size determines the connectivity and pace of life of the System, (3) connectivity determines the frequency of successive systemic wars and their severities, (4) the number of degrees of freedom in the System are determined by the intensity of rivalries between Great Powers in the System, (5) the number of the degrees of freedom in the System determine the nature of non-systemic war dynamics during relatively stable periods ($n = 2$: periodic, $n > 2$: chaotic), (6) certain dynamics and structures of the System crystalize into fractals, and (7) the connectivity of the System determines the size of non-systemic wars and the ability of the System to store free energy (tensions), and to eventually become critical.

215 Certain laws and mechanisms that apply to the System produce deterministic dynamics and properties.

KEY WORDS *Deterministic laws, Deterministic dynamics, Properties.*

Physical laws also apply to the System. These laws and related mechanisms make the System have a number of deterministic characteristics. The table below specifies these laws and mechanisms and shows how they relate to certain deterministic dynamics and properties of the System. The 'free energy principles' I discuss concern the second law of thermodynamics.

Laws, mechanisms, and related deterministic dynamics

Laws and mechanisms	Related deterministic dynamics and properties
Free energy principle: 'free energy will be put to work'. Free energy is produced by the intrinsic incompatibility between increasing connectivity and security; a property of anarchistic systems. This incompatibility, in combination with a number of other characteristics of the System, produced a finite-time singularity accompanied by four accelerating cycles (1495-1945). Connectivity is the driver of the anarchistic System.	Related deterministic dynamics and properties of the finite-time singularity accompanied by four accelerating cycles, include: (1) the life span of cycles and their respective components; relatively stable periods and systemic wars, (2) the deterministic nature of non-systemic release events, (3) the timing, duration, and severity of successive systemic wars, (4) the moment when the singularity dynamic reaches a critical connectivity threshold (the singularity in finite time) and a phase transition becomes unavoidable, (5) the nature of the outcome of the phase transition; dedicated non-anarchistic hierarchies in the core of the System.
Free energy principle: 'implementing upgraded order that enables a lower energy state of the System'.	Order in the System is achieved through systemic war. Related deterministic properties include the degree of structural stability, robustness and fragility the upgraded order provides during the relatively stable period that follows the systemic war.
The number of degrees of freedom determines the nature of the deterministic non-systemic release dynamics (of non-systemic wars).	The level of rivalry between states in the System determines the number of degrees of freedom of the System. In case of more than two ($n > 2$) degrees of freedom, the nature of the deterministic non-systemic release events is chaotic, implying intrinsic unpredictability of the size, severity, and timing of these events. In case of $n = 2$, the deterministic non-systemic energy releases are periodic and thus more regular and predictable (during the first exceptional period, 1657-1763), or subdued (during the second exceptional period, 1953-1989). In periodic conditions, the System lacks mechanisms that restrain and control the energy level of the System ('intrinsic inhibition'); a third degree of freedom introduces chaotic dynamics and provides such a mechanism. The System becomes hyper-excited during $n = 2$ conditions and produces release events that release high levels of free energy. Chaotic conditions ($n > 2$) during relatively stable periods are a prerequisite for the System to become critical, produce a systemic war and upgrade its order to allow for a lower energy state of the System.

Laws, mechanisms, and related deterministic dynamics	
A high-connectivity effect producing local stability and a free energy release deficit	During the life span of relatively stable periods, at a tipping point the System reaches a high-connectivity regime. During high-connectivity regimes that typically precede critical periods (systemic wars), increasing connectivity implies increasing local stability of the nodes (states) of the System, resulting in a decrease in the size of non-systemic release events. The high-connectivity and (resulting) local stability allow for the build-up of free energy in the System and the formation of vulnerable issue clusters with fractal structures. The free energy release deficit and the percolation of vulnerable issue clusters are prerequisites for the System to become critical, produce systemic wars, and implement upgraded orders.
Connectivity effects	Apart from the high-connectivity effect, connectivity growth has a number of related deterministic effects, including: (1) an increase in the pace of life of the System, (2) an accelerating frequency of systemic wars, (3) an accelerating growth rate of the free energy that is produced and will be released by successive systemic release events (systemic wars), and an increase in the (4) structural stability, (5) robustness, and (6) fragility of the System.

Table 99 *This table shows the relationship between laws and mechanisms that apply to the System, and the deterministic dynamics and properties they produce in the System.*

216 Each mechanism and dynamic in the deterministic domain has its contingent counterpart, and vice versa.

KEY WORDS *Deterministic domain, Contingent domain, Properties, Mechanisms, Dynamics, Counterparts.*

It is possible to identify contingent counterparts ('equivalents') in the System for each deterministic property and phenomenon, and vice versa. The table below shows a number of deterministic and contingent 'counterparts'.

Deterministic and contingent counterparts	
Deterministic properties, mechanisms, and dynamics	Manifestation in the contingent domain
Connectivity growth and free energy production.	Increased interdependence, accompanied by increasing tensions.
Application of the second law of thermodynamics to free energy produced in the System as a consequence of the intrinsic incompatibility between connectivity and security in anarchistic systems.	The 'emergence' of a finite-time singularity dynamic, accompanied by four accelerating cycles.
Consistent with the second law of thermodynamics free energy is put to work to implement upgraded orders that allow for a lower energy state of the System.	Implementation of international orders with increasingly comprehensive arrangements, through systemic wars.

Deterministic and contingent counterparts	
Criticality, critical point.	Systemic war.
Intrinsic incompatibility between connectivity and security in anarchistic systems.	Intrinsic incompatibility between interdependence and security in anarchistic systems.
Path-dependence and lock-in towards increasing levels of order with increasing structural stability.	Path-dependence and lock-in towards successive international orders with increasingly comprehensive organizational arrangements; a process of integration
Competition between order (a lower energy state) and disorder (a higher energy state).	Competition between change and status quo. New order is implemented in the contingent domain by systemic wars. Systemic wars are ordering forces and cause change.
Realignment of nodes in the System during criticality to increase the System's structural stability and lower its energy state.	Implementation of changes in successive international orders during systemic wars, through 'privileges' that reflect the actual position of Great Powers in the (updated) status hierarchy of the System.
Increasing local stability of nodes of the System during high-connectivity regimes of relatively stable periods.	Decreasing size of non-systemic wars during high-connectivity regimes of successive relatively stable periods.
Increasing overall stability and optimization of the System, through crystallization in fractal structures, that minimizes free energy production (during relatively stable periods), and optimizes the deployment of destructive energy during critical periods (systemic wars).	A decrease in Great Power status dynamics, and a simultaneous decrease in changes in physical properties of the System (sizes of states). Eventually, the size distribution of states could be best described by a power law.
Coevolution of nodes (states) and of self-organized collective structures (international orders).	A 'powerful-become-more-powerful' dynamic; coevolution of certain properties of states and the international orders they design and implement.
A dual-phase transition when the critical connectivity threshold (the singularity in finite time) of the anarchistic System was reached in 1939.	The simultaneous implementation of two non-anarchistic hierarchies in the core of the System (Europe), and the first global order at a global scale, through the Second World War (1939-1945).
The second law of thermodynamics and related free energy principles.	The urge to survive of states and their populations.

Table 100 *This table shows a number of deterministic properties, mechanisms, and dynamics and their contingent counterparts.*

217 The deterministic domain determines the latitude of the contingent domain and its (contingent) dynamics.

KEY WORDS *Deterministic domain, Contingent domain, Contingent latitude.*

The fact that a deterministic domain (for example) determines the timing, duration, and also the amount of destructive energy that has to be deployed during successive systemic wars implies that the playing field of the accompanying contingent domain was (and still is) seriously restricted. Contingent dynamics were increasingly encapsulated by a progressively restricting set of parameters. The finite-time singularity dynamic produced systemic wars with increasing intensities at accelerating rates, pushing the anarchistic System towards further integration and cooperation in the contingent domain in the System.

218 Deterministic laws, including the second law of thermodynamics, determine the latitude for contingent dynamics in the contingent domain of the System.

KEY WORDS *Deterministic domain, second law of thermodynamics, Free will, Contingent domain, Contingent latitude.*

It is possible to distinguish a deterministic and contingent domain in the (dynamics of the) System. These domains are complementary and interact through an 'interface' that includes the security dilemma and interacting self-fulfilling prophecies between states; the distinction between two domains serves above all analytical purposes.

Because of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems, population growth and rivalries between states (both result in increasing connectivity of the System) cause the production of free energy (tensions) in the anarchistic System; the second law of thermodynamics also applies to the free energy (tensions) produced in the System. The fact that free energy is produced, and the second law of thermodynamics applies are deterministic properties. Application of the second law of thermodynamics to the free energy (tensions) produced in the anarchistic System, resulted in the development and unfolding of a highly deterministic finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945).

The second law of thermodynamics – through the finite-time singularity dynamic – in fact determined when the anarchistic System would become critical, produce systemic wars, and had (in other words) to implement upgraded orders that allowed for lower energy states of the System. The second law of thermodynamics not only determined the 'exact' timings of systemic wars, but also their duration (related to the pace of life of the System), and the amounts of free energy that had to be deployed in the form of destructive energy, to design and implement upgraded orders, with specific degrees of structural stability. Wars are in other words not products of 'free will', but deterministic energy releases, that obey the second law of thermodynamics.

Although a number of key-characteristics of systemic wars are determined by physical laws, there still is (some) latitude for contingency; the second law of thermodynamics determines (for example) that upgraded orders must be implemented in the deterministic domain of the System, but is indiscriminate about how these orders are organized in the contingent domain, and what ideologies for example justify their existence and regulate their (inter)actions. The second law of thermodynamics is indiscriminate regarding contingent choices and dynamics as long as its demands are met.

219 By implementing two dedicated non-anarchistic hierarchies in the core of the System (Europe), the free energy production in the System was reduced, consistent with the demands of the second law of thermodynamics.

KEY WORDS *Intrinsic incompatibility, Critical connectivity threshold, Free energy, second law of thermodynamics, Order, Dedicated non-anarchistic hierarchies.*

In a bounded and growing anarchistic System, terms that respectively refer to available resources to fulfill basic requirements and population growth, humans and the 'organizations' into which they clustered (tribes, groups, units, states), became increasingly dependent on each other to fulfill their basic requirements and ensure their survival.

Increased connectivity of the anarchistic System had two contradictory effects: on the one hand it increased the collective ability of units (states) and their populations to fulfill basic requirements and survive, and on the other hand it increased the number of security issues and tension levels between these units (states). The multitude of interactions between units and their populations, in combination with their urge to survive, produced a self-organized singularity dynamic accompanied by four accelerating cycles during the 1495-1945 period.

The moment (1939), the anarchistic System reached the critical connectivity threshold and produced 'infinite' amounts of free energy (tensions between states) as a consequence of the (by then) infinite incompatibility between connectivity and security in the anarchistic System, the System had reached the limits of its ability to create upgraded orders in an anarchistic context, that could ensure a lower free energy state, and a new period of relative structural stability, necessary for humans and their structures to fulfill their basic requirements. The peculiar condition of the anarchistic System at the critical connectivity threshold meant that, through the singularity dynamic, it produced systemic energy releases at an 'infinite' frequency and with 'infinite' amplitudes (at least in theory). This condition, implying permanent criticality, resulted in an unavoidable phase transition: The System could not produce these infinite dynamics with infinite energy requirements, as dictated by the second law of thermodynamics. The condition was not only unsustainable because of infinite energy requirements and the infinite destruction this implied, but also because this dynamic did not allow humans and their structures to exploit relatively stable periods to ensure the balanced fulfillment of their basic requirements.

Solving the incompatibility between increasing connectivity and security in anarchistic systems, the mechanism at the heart of the singularity dynamic, could stop the production of infinite levels of free energy by the System. Either decreasing connectivity of the System or neutralizing anarchy could accomplish this. Because increasing connectivity is a function of population growth, 'decreasing connectivity' was not an option; instead, the System implemented dedicated non-anarchistic hierarchies in the core of the System, that ensured that, at least within these hierarchies, anarchy and free energy production were neutralized.

220 The tendency for order in the System is stronger than the tendency for disorder.

KEY WORDS *Singularity dynamic, Competition, Order, Disorder, Dual-phase transition, second law of thermodynamics.*

The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) was a conflict between two tendencies of the System: a tendency towards order, that is, integration in the contingent domain, and towards disorder, as a result of the free energy (tension) that is produced. Increased connectivity was (and still is) the driver of the System, and its dynamics; connectivity growth resulted in increasing levels of free energy. The second law of thermodynamics dictates that free energy will be put to work to implement upgraded orders that allow for a lower energy state of the System. Upgraded orders were implemented through systemic wars; systemic wars were manifestations of criticality of the System.

During the relatively stable periods that followed systemic wars (the lower energy states'), the disorder, the levels of dysfunctional free energy, and the tensions constantly increased as a consequence of continued connectivity growth of the anarchistic System. When the System again reached criticality, upgraded orders were implemented to cope with the increased level of connectivity of the System at that point in time.

When the System in 1939 reached the critical connectivity threshold (the singularity in finite time), the anarchistic System was no longer able to implement an upgraded order that could reconcile the high level of connectivity of the System (and the infinite amounts of free energy it implied at that point) with the collective security requirements of states. The implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a (first) global order at a global scale, through a dual-phase transition (the fourth systemic war, the Second World War, 1939 - 1945) overcame this unsustainable condition. Anarchy was neutralized within both dedicated hierarchies, significantly lowering the amounts of free energy (tensions) produced in the System (at least temporarily), consistent with the requirements of the second law of thermodynamics.

The dynamics and developments the finite-time singularity produced, as a consequence of the competition between order and disorder, ultimately resulted in the implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe). The successive upgraded orders the System produced, including both dedicated hierarchies, are the 'products' of the second law of thermodynamics. The upgraded orders the System produced, provided in the contingent domain the right 'context' and conditions to implement 'accompanying' international orders. International orders, including their organizational arrangements, institutions and rule-sets, are contingent manifestations of the upgraded orders provided by the second law of thermodynamics.

221 Upgraded orders that were implemented through successive systemic wars became obsolete at an accelerating pace.

KEY WORDS *Connectivity, Free energy, Acceleration, Critical connectivity threshold, Collapse, Dual-phase transition, Dedicate non-anarchistic hierarchies.*

Because the population and the connectivity of the anarchistic System continuously grew (1495-1945), and at the same time the rivalry between states continuously increased, upgraded orders that were implemented through the first three systemic wars could be only temporarily effective.

Despite the fact that successive orders were, from an organizational design point of view, progressively comprehensive in their level of organization, it was only a matter of time before they collapsed (1792, 1914, 1939), as a consequence of free energy that was produced in the System at an accelerating rate.

On each occasion, the anarchistic System encountered the limits of the upgraded orders at an accelerating pace. The point is that the first three orders did not address the fundamental underlying issue of the System: the intrinsic incompatibility between connectivity and security in anarchistic systems. When the anarchistic System ultimately reached the critical connectivity threshold in 1939, the System produced 'infinite' amounts of free energy (tensions) and upgraded orders had to be implemented at an infinite rate, requiring infinite levels of destructive energy. This unsustainable condition resulted in the collapse of the anarchistic System (1939), and in response, through a dual-phase transition (the fourth systemic war, the Second World War, 1939-1945) and consistent with the second law of thermodynamics, two dedicated non-anarchistic hierarchies and a first global international order, were simultaneously implemented, respectively in Europe (the core of the System), and at a global scale of the System.

222 The development and unfolding of the finite-time singularity dynamic (1495 - 1945) required the ability of humans and populations for mass deception.

KEY WORDS *Singularity dynamic, Mass deception.*

The increased levels of order that the second law of thermodynamics forced onto the System to meet its requirement for a lower energy state, provided the foundation for states in the System to implement cooperative agreements and structures (international orders). The implementation of these cooperative agreements and structures was not the outcome of a learning process of humans and social systems, as is often suggested, but was the response domain of states and their populations in the contingent to deterministic requirements of physical laws that had to be accommodated.

The flexibility of humans and states in Europe (for example) to switch, in a very short time span, from extreme destruction (the fourth systemic war, the Second World War, 1939-1945) to intensive cooperation (the implementation of two dedicated non-anarchistic hierarchies, 1945- …), is indicative of the ability of humans and social Systems to justify their interactions, as required by the second law of thermodynamics. Without our flexibility to justify extreme collective behaviors and our ability for mass deception, the singularity dynamic could not have developed and unfolded. It can be argued that this flexibility of mind and behavior of humans and social systems, is a prerequisite for (collective) survival.

223 The deterministic and contingent domains of the System interact and coevolve.

KEY WORDS *Deterministic domain, Contingent domain, Coevolution.*

The abnormal war dynamics during the exceptional period (1657 - 1763) provide us, as discussed elsewhere, with a number of valuable insights. They also show how the contingent and deterministic domains of the System interact and coevolved (as a consequence). As a consequence of the intense rivalry between Britain and France during the period 1657-1763, the number of degrees of freedom of the System was temporarily decreased to two. Deterministic laws determine that two degrees of freedom ($n = 2$) produce non-chaotic and (during 1657-1763) periodic dynamics; whereas more than two degrees of freedom ($n > 2$) produce chaotic non-systemic war dynamics. Periodic conditions during the first exceptional period (1657-1763) resulted in hyper-excited and extreme non-systemic war dynamics; chaotic conditions, on the other hand, produced more restrained, but also intrinsically unpredictable, non-systemic war dynamics.

The development of the System during the second relatively stable period (the second international order, 1648 - 1792; an era that includes the exceptional period) shows how the abnormal non-systemic war dynamics (1) produced a delay in the start time of the second systemic war (the French Revolutionary and Napoleonic Wars, 1792–1815) and led – I assume - to a delay in the further unfolding of the singularity dynamic and (2) led to deployment of extreme levels of destructive energy during this specific period. The exceptional period shows how contingent developments such as rivalries between states determined the number of degrees of freedom in the System and, as a consequence, the nature of its non-systemic war dynamics and the delayed unfolding of the singularity dynamic. The abnormal non-systemic war dynamics during the first exceptional period (1657-1763) show how both domains interact, and influence their (mutual) development.

224 The properties of the singularity dynamic were already contained in the initial conditions of the System at its inception in 1495.

KEY WORDS *Singularity dynamic, Properties, Initial conditions.*

At the core of the System and its development, and at the core of historical events as we know them, is a self-organized deterministic singularity dynamic accompanied by four accelerating cycles (1495-1945) that is a manifestation of the second law of thermodynamics. The conditions of the System at its inception (1495) and the deterministic laws that apply to the System's dynamics, already contained the properties defining how the singularity dynamic would unfold. Deterministic properties of the singularity dynamic include for example when, how many times, and with what (accelerating) frequency the System would become critical and produce systemic wars to implement upgraded orders, the duration of critical periods (systemic wars), the amounts of energy that had to be put to work to implement upgraded orders, and when the System would reach a critical connectivity threshold of a singularity in finite time and collapse.

Initial conditions that defined the singularity dynamic include (1) the size of the network (System), (2) the System's connectivity and growth of connectivity (determined by population size and growth), (3) the frequency and intensity of interactions between nodes (states) of the network, (4) the amount of free energy that was produced by those interactions, and (5) decision rules of states regarding wars that define the binary switches of the network.

225 In the System, randomness and organization went hand in hand.

KEY WORDS *Deterministic domain, Contingent dynamics, Randomness.*

Regarding self-organized critical (SOC) systems, Bak posed the following questions, that also concern the anarchistic System, despite the fact that the System not qualifies as a SOC-system: "*How can a system evolve to an organized state despite all the obvious randomness in the real world? How can the particular configuration be contingent on minor details, but the criticality totally robust?*" (5). These questions also apply to the System. *How can the System evolve to an organized state and produce a highly deterministic singularity dynamic despite all the randomness in the System? And how can the singularity dynamic be contingent on minor details, but also be totally robust?*

These questions suggest that contingency and deterministic properties contradict each other; that is, however, not the case; in case of the System (and probably other systems) both domains are complimentary and form an integrated 'whole': the deterministic domain ('governed' by deterministic laws) determines the latitude of the contingent domain, of contingent dynamics in the System. Contingent dynamics are contingent as long as they do not violate physical laws.

Human and social dynamics are partially contingent in nature, but also obey certain deterministic laws that apply to these dynamics. Deterministic laws constrain and shape contingent dynamics. A multitude of highly contingent interactions at a micro level of the System produce tensions that are representations of free energy to which deterministic laws, including the second law of thermodynamics, apply. The application of these laws produced a finite-time singularity dynamic accompanied by four accelerating cycles (1495 - 1945), that, during the course of its unfolding, progressively shaped the multitude of highly contingent micro interactions between the states that produced it.

Thus, although issues and tensions added free energy to the System through random highly contingent events, the System evolved to a highly organized state through the application of the second law of thermodynamics and related principles. The randomness with which free energy was added to the System did not affect the deterministic nature and resultant consistency of the singularity dynamic. Randomness is irrelevant for the complex and highly regular behavior that can be observed; they do not contradict.

226 During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the System's dynamics became increasingly constrained.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Acceleration, Pace of life, Lock-in.*

Because of the path-dependent nature and resulting lock-in of the System's dynamics, the System increasingly became constrained in its dynamics and development.

Because free energy in the System was produced at an increasing rate, the System required re-ordering by systemic wars at an accelerating frequency and with increasing energy levels, consistent with the second law of thermodynamics. When the pace of life of the System increased and the unfolding of the singularity dynamic accelerated, the dynamics and development of the System were progressively shaped by systemic war activity. This lock-in increasingly restricted the contingent domain; activities of states increasingly locked in on war and on preparation for war.

227 To ensure the development and unfolding of the finite-time singularity accompanied by four accelerating cycles (1495-1945), the deterministic domain made increasing demands on the contingent domain and forced states and societies in the System to develop increasingly extreme ideologies and doctrines that ensured the availability of sufficient destructive energy.

KEY WORDS *Singularity dynamic, Self-reinforcement, Lock-in, Totality of war, Coevolution, Ideologies.*

The lock-in of the anarchistic System on the accelerated implementation of successive upgraded orders through a self-reinforcing finite-time singularity dynamic impacted the dynamics of the contingent domain: States and populations necessarily became increasingly focused on (systemic) war and preparation for war. The lock-in process necessarily evolved hand-in-hand with the increasing totality of successive systemic wars. 'Totality of war' refers to the amount of resources that are deployed to fight wars. To meet the demands of the second law of thermodynamics (increasingly intense systemic wars, that had to be produced at accelerated rates), destructive energy had to be produced, mobilized, and deployed in increasing amounts; this could only be accomplished, if states involved all domains of their societies and populations in the preparation and conduct of wars.

This requirement also explains why increasingly extreme political ideologies and military doctrines were developed and exploited: to justify the mobilization of societies, the suffering that had to be endured, and the total destruction that to be afflicted on hostile states and societies.

228 The outcome of the finite-time singularity dynamic accompanied by four accelerating cycles – of the dual-phase transition (1939-1945) – was in some respects pre-determined, but in other respects contingent. Different contingent 'configurations' - solutions - could have met the deterministic demands of the second law of thermodynamics.

KEY WORDS *Singularity dynamic, Deterministic domain, Contingent domain, second law of thermodynamics, Order, Dedicated non-anarchistic hierarchies.*

Certain deterministic properties of the System, including the timing of the critical connectivity threshold in 1939, the number of accelerating cycles that accompanied the singularity dynamic, the life span of the cycles, and the timing and duration of critical periods (systemic wars), were pre-determined by the second law of thermodynamics. These pre-determined requirements also include properties of upgraded orders, e.g. the lower energy states that had to be accomplished.

These deterministic properties defined the latitude that was left for contingent dynamics. Ultimately, in 1939 when the anarchistic System reached the critical connectivity threshold, the anarchistic System produced 'infinite' amounts of free energy, that had to be put to work, to meet the requirements of the second law of thermodynamics; a lower energy state of the System.

Because free energy production is a result of the intrinsic incompatibility between (increasing) connectivity (population growth) and security in anarchistic systems, a lower energy state could (basically) be accomplished in two ways: by decreasing the connectivity of the System, or by neutralizing anarchy; in other words, by annulling the intrinsic incompatibility of the System altogether.

Although 'connectivity decrease' was not a viable option, in principle, the System had a choice. However, this choice not only concerns the choice between 'connectivity decrease' and 'neutralization of anarchy'; I assume that different configurations of dedicated non-anarchistic hierarchies in Europe (other than the Western and Eastern hierarchy, respectively controlled by the United States and the Soviet Union, we know), also could have met the requirements of the second law of thermodynamics (a lower energy state of the System).

Although the implementation of dedicated hierarchies was a logical next step, the number of hierarchies that would be implemented and the (internal) organizational arrangements they included were not predetermined, but were dependent on contingent factors and conditions. The deterministic domain – so to say – 'does not care' what happens in the contingent domain, as long as its (unavoidable) requirements are met. See also next statement for alternative scenarios that could have unfolded within the available contingent latitude.

229 Different contingent scenarios could have unfolded during and following the fourth systemic war (the Second World War, 1939-1945), assuming that they meet the deterministic requirements of the second law of thermodynamics.

KEY WORDS *Contingency, Scenarios.*

To further emphasize and explain the impact of contingency, I discuss a number of scenarios that, depending on contingent variables, could (probably) also would have met the deterministic demands of the second law of thermodynamics. The (alternative) scenarios I propose, have in common that in all cases dedicated non-anarchistic hierarchies are implemented in the core of the System (Europe), to ensure that the production of free energy is limited and the requirements of the second law of thermodynamics are met.

1 *Scenario 1: A fascist Europe*

This scenario is based on the assumptions that Germany was able to consolidate its territorial expansion and that fascism successfully established a dedicated hierarchy in Europe, neutralizing anarchy and the security dilemma in territories under Fascist control.

2 ***Scenario 2: A communist Europe***
In case of this scenario, the Soviet Union successfully 'pushed back' Germany, destroyed fascism and established full control in Europe. In that case, communism, not fascism, would have been implemented as the integrative ideology in the core of the System. This scenario could have developed if, for example, the United States had chosen not to interfere in European affairs, or if the Normandy landings had failed.

3 ***Scenario 3: A democratic and capitalist Europe ('without delay')***
This scenario would have developed, for example when the United States had decided to interfere in Europe at an earlier stage and/or if the Normandy-landings were conducted successfully in 1943, as initially intended; or in case the Soviet Union had been confronted with stronger German resistance on the East front during their advance towards Berlin. A dedicated democratic and capitalist non-anarchistic hierarchy ('the European Union', so to say) would have extended to the Russian border starting in 1945, and not have been implemented at a later stage (in 1989) when the Eastern dedicated hierarchy collapsed, and parts of this hierarchy were 'absorbed' in the Western hierarchy.

4 ***Scenario 4: A delayed solution, one more systemic war***
In case of this scenario I assume that the fourth systemic war (the Second World War, 1939-1945) had not resulted in the implementation of two stable dedicated hierarchies in respectively Western and Eastern Europe; in other words, anarchy (between states) would have persevered in Europe. A fifth cycle would then have developed, with an even shorter relatively stable period, and a fifth systemic war (probably named the 'Third World War') would have been necessary, for a next upgrade of the System's order. The severity of the fifth systemic war would have been greater than that of its predecessor. Again, as was the case during the fourth international order, local stability would have prevented non-systemic wars from developing; the incompatibility between increasing connectivity and security would grow further, etc.

According to the mathematical equation that describes a finite-time singularity accompanied by four accelerating cycles (1495-1945), the fifth systemic war would have started in 1954.

In all scenarios, the System's contingent dynamics would have been consistent with the demands of the second law of thermodynamics, I assume. Although numerous properties of the singularity dynamic and systemic wars are deterministic in nature, much room is still left for contingency.

230 States and their populations are to a very high degree subject to deterministic laws that determine and shape their (collective) behaviors.

KEY WORDS *Deterministic domain, Contingent domain, Interface, Synchronization, Contingent latitude, Interacting self-fulfilling prophecies, Urge to survive.*

The highly deterministic finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) is a self-organized 'product' of the free energy (tensions) states produced in the anarchistic System, and deterministic laws (including the second law of thermodynamics) that apply to this energy. The deterministic domain determines the dynamics and development of the System, and the latitude for contingent dynamics in the contingent domain of the System.

The undisturbed unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles shows that states and populations always 'obeyed' the deterministic demands of (for example) the second law of thermodynamics, and responded very flexible to tensions in the System.

States and their populations started and stopped wars at exactly the right time. The security dilemma and interacting self-fulfilling prophecies between states ensured that the deterministic and contingent domains of the System were always synchronized. These two mechanisms – and the coevolution of states and successive international orders – also ensured that adequate political ideologies and military doctrines were in time available, to ensure the mobilizations of states and their populations, and to justify the increasing levels of destructive energy that had to be produced and deployed.

Pinker's observations that humanity has become progressively less violent over millennia and decades and that modernity, its cultural institutions, and the extraordinary power of progressive ideas are making us better people, are not consistent with the insights this study provides; it is just wishful thinking this study suggests (49). Deterministic laws that apply to the System's dynamics determine – 'decide' – what states, societies, and humans must do; 'free choice' - as far as it exists - is limited by the demands of the second law of thermodynamics. There only is free choice, as long as the deterministic demands of the second law of thermodynamics are met; as long as choices meet the demands of the second law of thermodynamics, this law will not interfere with the choices of states and societies in the contingent domain.

"Modernity, its cultural institutions, and the extraordinary power of progressive ideas" are not making us "better people", as Pinker suggest; We cannot (and do not) escape subjection to physical laws, as this study shows.

Pinker's observation that "humankind has become progressively less violent over millennia and decades", is (also) not supported by this study: during successive relatively stable periods, the number and frequency of non-systemic wars decreased linearly as a consequence of the increasing structural stability and robustness of successive relatively stable periods; effects that must be attributed to network-effects. At the same time as this happened, systemic wars (with accelerating severities) were produced at accelerating rates.

Evolution, the fundamental changes in the natures of species, including humans, does not function at a time scale of millennia, let alone decades, as Pinker implies. It is not the power of progressive ideas that produced our current System, modernity, and cultures.

The System, the finite-time singularity that unfolded, and their characteristics are products of deterministic laws the System has to obey, and of the ability of humans to effortlessly adjust their thinking and behavior – grounded in an urge to survive – to comply with the demands of these deterministic laws.

This study does not show the progress and 'power' of humanity to shape its world, but its flexible submission to a deterministic System and its dynamics, we (unknowingly) produced in our collective urge to survive: we created a trap we did not recognize, we always obeyed, and could always justify.

231 The timing of systemic wars, including the ultimate dual-phase transition (1939-1945) of the anarchistic System when its core (Europe) reached the critical connectivity threshold in 1939, is mere an application of certain physical laws and were already 'programmed' into the System at its inception.

KEY WORDS *Timing, Systemic wars, Dual-phase transition, Deterministic, Physical laws.*

The initial conditions of the System at its inception around 1495 already defined the singularity dynamic in detail, including the timing when the System would (four times) reach criticality during the 1495-1945 period, provided the anarchistic System would produce enough free energy to power the unfolding of the singularity dynamic. The 'powering' of the singularity dynamic was assured by population growth of states in the System; the unfolding of the singularity dynamic and population growth constituted (and still constitute) a self-reinforcing (positive feedback) mechanism.

232 Deterministic constraints + contingent latitude = contingent dynamics.

KEY WORDS *Deterministic domain, Constraints, Contingency, Latitude, Contingent dynamics, Decreasing contingent latitude.*

Laws that apply to the System impose deterministic constraints on its dynamics; these laws are not negotiable. The deterministic domain – deterministic constraints – determine the latitude that is left for contingency.

Which states fight wars, what reasons wars are fought for, how they are fought, etc. is to a high degree a matter of 'contingent latitude'; as long as these events (dynamics) do not conflict with the laws that apply, the deterministic domain – so to say – 'does not care'. Contingent dynamics – the dynamics we experience – are the outcome of deterministic constraints that apply, and the 'use' of the contingent latitude of the System.

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the deterministic domain 'demanded' (because of the accelerating production of free energy) that upgraded orders were implemented at an accelerating rate; and furthermore that increasing levels of destructive energy were deployed. These increasingly demanding requirements of the deterministic domain resulted in increasingly intrusive deterministic constraints, that increasingly limited the contingent latitude of the System; as a consequence, contingent dynamics increasingly locked in – had to lock in – on preparing for and fighting increasingly 'total' and severe systemic wars. The development of increasingly radical ideologies and political viewpoints – as happened during the fourth international order (1918-1939) – was (and still is) an integral and necessary component of this process of lock-in.

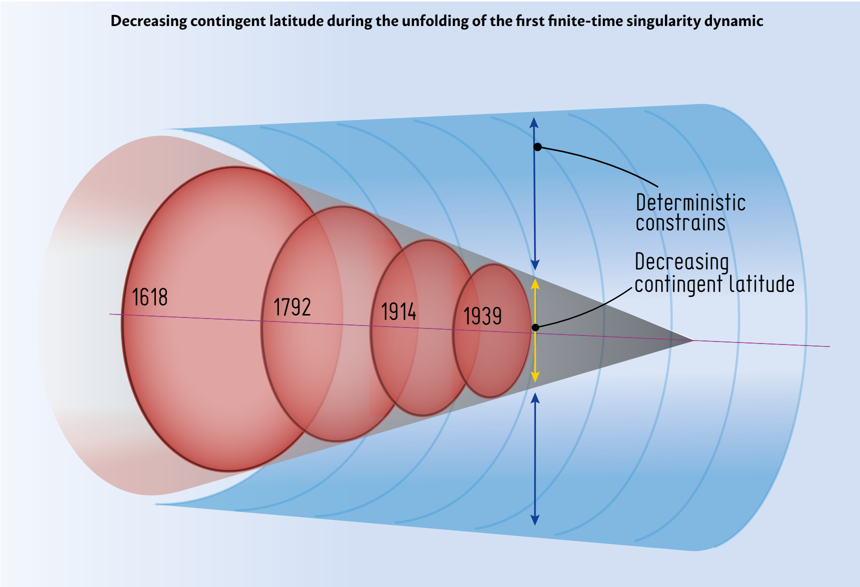


Figure 119 *This figure shows schematically the relationship between deterministic constraints imposed by the deterministic domain, and how these constraints impact on the 'shrinking' contingent latitude of the System, during the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945). Because the anarchistic System produced accelerating amounts of free energy (tensions), the System produced systemic wars at an accelerating rate, and with accelerating amplitudes (severities), to ensure compliance with physical laws that apply to the System. During the unfolding of the finite-time singularity dynamic, successive international orders – and especially the last (fourth) international order (1918-1939) that preceded the fourth systemic war (the Second World War, 1939-1945) – were increasingly dominated by preparations for an inevitable next systemic war. Radicalization of ideologies and political points of view were (and still are) integral 'parts' of these preparations, and necessary to enable the mobilization of societies for (increasingly) total war.*

During the unfolding of the finite-time singularity dynamic (1495-1945) the anarchistic System increasingly resembled a 'war machine' and 'war trap'.

15 INTERNATIONAL ORDERS, THE SECURITY DILEMMA AND INTERACTING SELF-FULFILLING PROPHECIES

233 Interacting self-fulfilling prophecies produce and shape issues that act as attractors around which tensions crystallize; these connected issues form vulnerable issue clusters that eventually percolate the System and cause it to become critical.

KEY WORDS *Interacting self-fulfilling prophecies, Attractor, Tension, Crystallization, Issue clusters, Percolation, Criticality, Systemic war.*

Interacting self-fulfilling prophecies between states form the interface between the deterministic and contingent domains of the System. Interacting self-fulfilling prophecies result in issues that can be further magnified by additional tensions the System produces. Issues can be considered attractors around which tensions crystallize. This process of crystallization results in the formation of underlying vulnerable issue clusters. When these vulnerable issue clusters percolate the System, it becomes critical and produces a systemic war.

234 The urge to survive, is the driver of humanity and social systems.

KEY WORDS *Critical connectivity threshold, Collapse, second law of thermodynamics, Dedicated non-anarchistic hierarchies.*

When the anarchistic System in 1939 reached the critical connectivity threshold (the singularity in finite time), it produced infinite amounts of free energy (tensions). At that point, systemic wars had to be produced at an infinite rate to meet the demands of the second law of thermodynamics. This was however, in theoretical and practical terms, not achievable.

In the contingent domain, this condition of the anarchistic System, resulted in a paradox. It was the need to fulfill their basic requirements that 'forced' states to fight wars, but at a certain point (the critical connectivity threshold,1939), war – supposed to ensure the survival of states and their populations – wars instead threatened states and the System to collectively self-destruct, because of the frequency with which wars had to be fought, and the amounts of destructive energy that had to be deployed to achieve a new relatively stable condition. War as a rational instrument of policy of states had in other words become obsolete.

Given the unsustainable condition of the anarchistic System in 1939, only two 'options' were available to ensure compliance with the second law of thermodynamics: a reduction in the connectivity of the System, or the abolishment of anarchy. Only through one of these two options, could the intrinsic incompatibility between (increasing) connectivity and security in the anarchistic System be resolved.

The connectivity of the System was closely related to – a function of – the size of the System's populations. Given the continuous increase in populations, a reduction in the connectivity of the System was not a feasible option.

The other option, abolishment of anarchy, on the other hand, could be achieved by implementing two dedicated non-anarchistic hierarchies in the core of the System (Europe); the three preceding upgraded orders that were implemented through the three preceding systemic wars, had 'prepared' the core of the System for this logical' next step.

Whereas initially, the urge to survive 'forced' states and populations in the anarchistic System to fight wars with other states, at a certain point, the 'same' urge to survive also forced states to implement non-anarchistic hierarchies, and accept a next level of social integration and expansion.

Our ability to interpret deterministic demands of the System (in this case the need to implement non-anarchistic hierarchies) as choices of free will, ensured that adequate structures (that would meet the deterministic demands of the second law of thermodynamics) could also be implemented in the contingent domain of the System.

An ability for (collective) deception, is intrinsic to human and social survival.

235 The two dedicated non-anarchistic hierarchies that were implemented through a dual-phase transition (the fourth systemic war, the Second World War, 1939-1945), merged into one extended hierarchy, when in 1989 the Eastern hierarchy collapsed.

KEY WORDS *Dual-phase transition, Fourth systemic war, Eastern hierarchy, Soviet Union, Collapse, European Union, 1989.*

In 1989 the Eastern hierarchy collapsed. I attribute this collapse to the inability of the Eastern hierarchy and the Soviet Union to maintain a certain balance that ensured the balanced fulfillment of basic requirements of populations of these systems. A number of specific conditions and (related) developments contributed to these imbalances, including: the authoritarian nature of integrative structures, the highly centralized economic regime that was applied, a lack of adaptability, and increasing demands the rivalry with the United States made on its internal organization and capabilities.

The collapse of the Soviet Union and the Eastern hierarchy had two effects: (1) the Soviet Union and Eastern hierarchy fragmented into independent states – the original building blocks of the Soviet Union and Eastern hierarchy – that regained full sovereignty, and (2) - the other effect - the global System lost the constraints on its dynamics caused by the intense rivalry between the United States and the Soviet Union, and could resume its 'default' chaotic non-systemic war dynamics. In 1989, the condition of the System changed from 'frozen' - highly ossified and stable and predictable - to 'fluid' and intrinsically unpredictable.

Eastern European states – attracted by the 'success' of the Western hierarchy and the United States were absorbed – included in - the Western hierarchy, that not only extended its geographic reach, but at the same time developed and implemented increasingly comprehensive integrative structures in efforts to further exploit economies of scale and scope that were now envisioned.

This process of expansion and further integration of what has become the European Union, is still ongoing and unfinished. The current condition of Europe – the European Union – can be best described as 'stuck in the middle': states have voluntarily abandoned and transferred typical state functions to a next level of organization ('Brussels'), while at the same time, the next level of organization is not yet fully crystallized and effective in taking over these responsibilities.

This stuck in the middle condition makes member states of the European Union, and the Union itself, vulnerable to internal and external challenges that cannot be – not anymore and not yet – adequately addressed. As a consequence, the European Union loses credibility and legitimacy. From a system- and network-perspective, this particular condition of the European Union – at least in a number of respects – is similar to the condition of the Eastern hierarchy before its collapse in 1989. A lack of internal balance in the European Union can also result in its fragmentation and the re-nationalization of its building blocks (states).

236 Successive 'European' and the first global orders coevolved and complemented each other, consistent with the demands of the second law of thermodynamics.

KEY WORDS *Coevolution, Dual-phase transition, Core, Non-core.*

As a consequence of the expansion of the System during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), and the development of autonomous dynamics outside of the System's core, non-European issues, tensions, and dynamics increasingly contributed to the buildup of tensions (free energy) in the (increasingly globalized) System.

Eventually core and non-core tensions – that were inseparably linked – were simultaneously put to work through the fourth systemic war (the Second World War, 1939-1945), that constituted a 'dual-phase. The dual-phase transition led to the simultaneous implementation of the (fourth) upgraded order in the core of the System (Europe, two dedicated non-anarchistic hierarchies), and the first global order at a global scale of the System.

Whereas the dedicated non-anarchistic hierarchies that were implemented in the core of the System (especially) addressed free energy production in Europe, the first global international order addressed global free energy production and tensions (including tensions in Europe). Both new orders were implemented as I mentioned through the fourth systemic war (the Second World War, 1939-1945) that produced two phase transitions, not coincidentally at the same time. Both orders, one regional and the other global, coevolved; one could not be established or effective without the other.

The relationship between the core (Europe) and the non-core of the System, preceding the dual-phase transition (1939-1945), was accomplished through the interests and political control European states over time had acquired and established over non-core territories (their colonies). During the dual-phase transition, the dominant roles of colonial powers diminished, while the United States and the Soviet Union at the same time strengthened their (global) positions and claims. Following the dual-phase transition (1945), the relationship between the now merged core (Europe) and non-core was accomplished through the political control the United States and the Soviet Union had simultaneously acquired over respectively the Western and Eastern hierarchies in Europe, and their dominant positions in the first global order.

237 In an anarchistic system, states cannot live with, but also not without each other.

KEY WORDS *Intrinsic incompatibility, Connectivity, Interdependence, Security, Free energy, second law of thermodynamics.*

Increasing connectivity and security are intrinsically incompatible in anarchistic systems, and this incompatibility results in the production of free energy (tensions between states). During the unfolding of the finite-time singularity dynamic (1495 - 1945), states in the anarchistic System became increasingly dependent on each other for the fulfillment of their basic requirements, including their mutual security. At the same time as basic requirements other than security could be fulfilled more effectively and efficiently by connecting to other states, increasing connectivity and interdependence also produced more issues and tensions; increasingly more insecurity. Because of the increasing connectivity (interdependence) of states, states became increasingly dependent on other states, and on functioning international orders, for their increasingly mutual security. The increasing dependence on functional international orders also means, that during successive systemic wars – when upgraded orders were designed and implemented – increasingly more was at stake for states. This development also contributed to the severity of successive systemic wars.

The increasing (security) interdependence of states means that over time states could increasingly not live without each other, but also not with each other. This paradox was eventually resolved when the anarchistic System in 1939 reached the critical connectivity threshold, and forced by the second law of thermodynamics, to implement two dedicated non-anarchistic hierarchies in the core of the System (Europe).

238 Through 'interacting self-fulfilling prophesies' between states in anarchistic systems, states collectively create their own realities that justify their decisions and (inter) actions; this mechanism is an intrinsic component of the finite-time singularity dynamic that developed and unfolded during the 1495-1945 period.

KEY WORDS *Deterministic domain, Contingent domain, Interface, Interacting self-fulfilling prophecies, Synchronization.*

If an analytical distinction is made between a deterministic and contingent domain, then one of the questions is how these domains interact; both domains are complementary, and together constitute the System. This distinction raises, for example, the question how it is possible for humans and states in the contingent domain to produce systemic wars at exactly the right time, with the right duration and energy levels, as dictated by the second law of thermodynamics; how do contingent and deterministic dynamics and requirements 'synchronize'? Despite the fact, that this is above all a theoretical ('artificial') perspective, this issue (question) provides further insights in the workings of the interface between both domains.

It should be kept in mind that the singularity dynamic accompanied by four accelerating cycles (1495-1945), is a self-organized macro dynamic that is 'collectively' produced by a multitude of micro interactions between states and their populations in an anarchistic system. As I explained, the second law of thermodynamics applies to the production of free energy these interactions result in. The emergence of the finite-time singularity dynamic 'in' the anarchistic System, was also not without consequence for the dynamics in the contingent domain of the System: Through 'our' multitude of micro interactions we in fact produced a macro dynamic – a context – (, the finite-time singularity dynamic), we continuously responded to and interacted with. The (deterministic) self-organized singularity dynamic 'forced' a series of wars on the contingent domain (consistent with the demands of the second law of thermodynamics). The accelerating dynamics of the finite-time singularity dynamic (especially the accelerating frequency of systemic wars) increasingly provided a context and meaning to contingent interactions: Micro interactions and macro dynamics coevolved, and reinforced each other. Free energy had to be released (as determined by the second law of thermodynamics), wars had to be fought (alternative release events are not available in anarchistic systems), and needed social context and justification in the contingent domain.

The security dilemma and interacting self-fulfilling prophecy mechanisms were instrumental in the coevolution of micro interactions (in the contingent domain) and macro dynamics (in the deterministic domain), and in the process of justification and sense-making in the contingent domain of the System.

The production of free energy (tensions) in the System is contained in the intrinsic incompatibility between increasing connectivity and security in anarchistic systems. These tensions were further reinforced and shaped by the security dilemma and interacting self-fulfilling prophecies between states.

Typically, in an anarchistic system, one state's security is another state's insecurity. If a state preventively deploys destructive energy to enhance its security, for example by stationing military units at borders or in contested seas, it will provoke counter deployments by other states. Application of this logic results in a self-reinforcing positive feedback mechanism, that leads to and justifies the production of more free energy in the System. The security dilemma, in combination with interacting self-fulfilling prophecies, also justify for states how (for what purposes, when, and where) additional free energy should be deployed in the System.

In anarchistic systems, assumptions regarding other states tend to be made true by one's own (re-)actions; one state's preventive actions unavoidably constitute threats for other states, which then apply the same logic to their preventive (re-)actions. In an anarchistic system, self-fulfilling prophecies are easily fulfilled and perceived threats will become true. An anarchistic system does not easily disappoint; states can create their own realities.

239 The Western hierarchy was better able to accomplish the balanced fulfillment of the basic requirements of its populations.

KEY WORDS *Basic requirements, Balance, Integrative structures, Collapse.*

The collapse of the Eastern hierarchy in 1989 raises the question of why this hierarchy, and not the Western hierarchy, collapsed. I argue that the Eastern hierarchy and the Soviet Union were at a certain point no longer able to ensure the balanced fulfillment of the basic requirements of their populations; their economic systems lacked the flexibility to meet the (evolving) requirements of their populations. Demand and supply could not be matched and their integrative systems lacked the necessary legitimacy to claim full control over their populations. The limitations of the Eastern hierarchy's planned economy and its integrative system reinforced each other.

The Western hierarchy, on the other hand, was better able to ensure the balanced fulfillment of the basic requirements of its populations. Its integrative system, based on democratic principles, was more effective and did not lack legitimacy; its capitalist economic system was better able to match demand and supply, and adjust to changing circumstances.

The Western hierarchy and the United States that Great Power that 'controlled' the hierarchy, were not only more effective in fulfilling the basic requirements of their constituents, but also more effective in defining and shaping the rivalry with the Eastern hierarchy and the Soviet Union.

The over-connectedness of the System (during the second exceptional period, the Cold War, 1953-1989), of which the strategy of mutual assured destruction (MAD) was a profound manifestation, prevented the release of free energy through non-systemic wars that would have allowed for a lower energy state of the System. The MAD-condition of the System disqualified war as a useful instrument for resolving issues and tensions in the System.

By developing and introducing superior technologies and war-fighting doctrines, and by raising threat levels, both blocs continuously tried to maintain or gain the upper hand, and to avoid a vulnerable position that could be exploited by the rival (other hierarchy). The security dilemma further pushed the Eastern hierarchy and the Soviet Union to its limits by destabilizing its already fragile internal balance. The organizing principles of the Western hierarchy were better able to meet the demands made by the second law of thermodynamics.

240 The security dilemma and the 'interacting self-fulfilling prophecies' mechanism link the deterministic and contingent domains of the System.

KEY WORDS *Deterministic domain, Contingent domain, Interface, Security dilemma, Interacting self-fulfilling prophecies, Synchronization.*

The interactions of states and their populations are at the basis of the finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period.

The self-organized finite-time singularity dynamic is the product of a multitude of interaction between states and populations in the anarchistic System. The self-organized singularity dynamic was 'powered' by the free energy that is typically produced in anarchistic systems, because of the intrinsic incompatibility between (increasing) connectivity and security in this category of systems.

Consistent with the requirements of the second law of thermodynamics, the increasing amounts of free energy that was produced, was periodically (at an accelerating rate) put to work, to implement upgraded orders in the System, that allowed for lower energy states in the System (new relatively stable periods).

As I explained, states, the finite-time singularity dynamic, and the successive orders it produced, coevolved, and these coevolving dynamics became increasingly path-dependent and locked-in on the production, mobilization, and deployment of ever-increasing levels of destructive energy.

Regarding the dynamics and development of the System, it is possible to distinguish between a deterministic and a contingent domain. Certain dynamics and their properties are determined by physical laws and restrict the choices humans, states, and populations can make in the contingent domain. The distinction between deterministic and contingent domains is above all an analytical distinction. If this distinction is made, the question is how the two complementary and integrated domains interact.

Two closely related mechanisms are responsible for the synchronization and interaction of both domains: (1) *the security dilemma*, a self-reinforcing positive feedback mechanism that contributes to the production of free energy in the System by (further) intensifying rivalries between states, and (2) *interacting self-fulfilling prophecies of states* that provide decision makers of states and populations with justification to (preventively) deploy destructive energy and help them to make sense out of their environment.

Both mechanisms, the security dilemma and interacting self-fulfilling prophecies, allow all actors (decisions makers of states, populations, etc.) in the anarchistic System to create the world they predict: each action in an anarchistic system, in reaction to a perceived threat, will be confirmed by the unavoidable reaction it will provoke by the actor that is seen as hostile. In an anarchistic system action is reaction; a mechanism that often confirms one's suspicions and assumptions, whether correct or not correct. The security dilemma and interacting self-fulfilling prophecies, feed on each other link both domains. They produce the tensions and free energy that build up in the System (to which deterministic laws apply), and provide the justification for its deployment in the contingent domain of the System.

241 Humans, states, and populations are very flexible in adjusting their (collective) state of mind to the deterministic requirements (war, no-war, integration, etc.) of the singularity dynamic.

KEY WORDS *Security dilemma, Interacting self-fulfilling prophecies.*

A multitude of interactions between states in the anarchistic System produced a highly deterministic self-organized finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945). The interactions between states and the finite-time singularity dynamic reinforced each other. Ultimately, when in 1939 the anarchistic System reached the critical connectivity threshold, the finite-time singularity dynamic produced a dual-phase transition. The finite-time singularity is a manifestation of the second law of thermodynamics.

The second law of thermodynamics determines when (in case of what conditions) the System has to produce energy releases (wars) to ensure compliance with its requirements. The security dilemma and interacting self-fulfilling prophecies between states are instrumental in the process of synchronization of the mindsets of their decision makers and populations, and the demands of the second law of thermodynamics. This process of synchronization ensures that decision makers in states switch 'on time' from 'no war' to 'war,' and vice versa, as demanded by the second law of thermodynamics.

The very regular unfolding of the singularity dynamic shows that we are very flexible and creative in aligning our (collective) motivations and justifications with the demands of the second law of thermodynamics. The 'same' creativity and flexibility of decision makers and populations that enables us to deploy infinite levels of destructive energy on other states and their populations, also allows us to collectively decide to implement dedicated non-anarchistic hierarchies and to cooperate in order to fulfill our basic requirements and ensure our survival. The ability to avoid cognitive dissonance when survival is at stake is an attribute that contributes to our collective survival. The singularity dynamic could only develop and unfold because of these human characteristics.

242 During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), states developed increasingly extreme political ideologies and military doctrines, instrumental in mass mobilization of populations and societies, and in the justification of the deployment of ever-increasing levels of destruction, as required by the second law of thermodynamics.

KEY WORDS *Singularity dynamic, Acceleration, Collapse, Ideologies.*

A multitude of interactions between states in combination with the binary network of 'war' or 'no war' switches states formed, produced a self-organized highly deterministic finite-time singularity accompanied by four accelerating cycles that developed and unfolded in the System during the 1495-1945 period.

In 1939 when the System ultimately reached the critical connectivity threshold (the singularity in finite time), the System produced a dual-phase transition (the fourth systemic war, the Second World War, 1939-1945) that led to the simultaneous implementation of two dedicated non-anarchistic hierarchies in Europe and the first global order at a global level of the System.

The intrinsic incompatibility between increasing connectivity and security in anarchistic systems was at the core of this dynamic, resulting in the production of ever-increasing, and ultimately infinite, amounts of free energy (tensions). Consistent with the demands of the second law of thermodynamics, the free energy that was produced was periodically put to work to implement upgraded orders that allowed for a lower energy state of the System.

Because free energy (tensions) was produced at an increasing rate (and in increasing amounts), the anarchistic System became critical at an accelerating rate and produced systemic wars with accelerating frequencies and severities. The severity of systemic wars is indicative of the free energy the System had produced, and a measure of the destructive energy states deployed during wars.

The 'undisturbed' development and unfolding of the accelerating finite-time singularity dynamic required the accelerated production, mobilization, and deployment of destructive energy by states. States were forced to comply with these requirements to ensure their (collective) survival. The accelerating singularity dynamic and the ability of states to ensure its development and unfolding coevolved and reinforced each other. As a consequence, systemic wars became necessarily increasingly 'total' over time. All resources of states were eventually mobilized (and had to), and as a consequence, populations and societies became legitimate targets for hostile states.

In order to accomplish mass mobilizations (for the production and deployment of increasing amounts of destructive energy), to justify the efforts populations and societies had to make, and to justify the destruction that had to be inflicted on, and endured by the enemy, states, and societies produced increasingly extreme political ideologies and military doctrines.

The development of these highly instrumental ideologies and military doctrines shows the almost boundless flexibility of states, populations, and societies to produce and, at the same time, obey the self-organized singularity dynamic that unfolded during the 1495-1945 period. Nationalism, fascism, and communism were highly instrumental in achieving mass mobilizations, and in justifying efforts and offers that had to be made. The security dilemma and interacting self-fulfilling prophecies not only were instrumental in producing, shaping, and justifying (preventive) deployments of destructive energy, but also provided justification for the development of increasingly extreme ideologies and doctrines.

243 Clausewitz's theory 'On War,' is an example of the timely - and highly instrumental -introduction of a military doctrine, consistent with the increasing demands of the singularity dynamic for more severe systemic wars.

KEY WORDS *Clausewitz, Military doctrine.*

The security dilemma and interacting self-fulfilling prophecies between states, and the (additional) tensions these mechanisms produced, not only inspired politicians to develop increasingly extreme ideologies, but also stimulated armed forces (armies and navies, etc.) of states to develop increasingly destructive war fighting doctrines. Clausewitz can also be considered a product of the increasing demands of the accelerating finite-time singularity dynamic (1495-1945).

Clausewitz's war theory was based on his observations and study of (especially) the Napoleonic wars (the second systemic war, 1792-1815). Clausewitz emphasized the political nature of war - its 'conceptual alignment' with and subordination to political ambitions and considerations- and by doing so contributed to the increasing totality of war. According to Clausewitz, "war is merely the continuation of politics (policy) by other means".

Clausewitz also stressed the necessity to destroy the enemy to ensure submission of the enemy (enemy states) to one's 'will' (political objectives).

Clausewitz's 'On War' provided politicians and military strategists with the 'logic' to deploy the increasing levels of destructive energy that were necessary to maintain the momentum of the finite-time singularity dynamic. The requirements of the unfolding singularity dynamic, the necessary mobilization of populations, and the ideologies and military doctrines that justified these efforts, coevolved and reinforced each other. Interactions between these 'variables' constitute a positive feedback mechanism that was powered by increasing levels of free energy that were produced as a consequence of the increasing incompatibility between connectivity and security in the anarchistic System.

244 A number of 'critical success factors' determine the power and influence of states, and their ability during systemic wars to achieve results that serve the interests of their states and populations.

KEY WORDS *Critical success factors, Power, Influence, Mobilization, Production, Deployment, Destructive energy, Total wars.*

The amount of destructive energy that states can produce, the ability of states to deploy destructive energy effectively and efficiently (a matter of political and military strategy and tactics), and the leverage that states can achieve through alliances and coalitions, determine the 'bargaining' position of states regarding the design and implementation of upgraded orders during systemic wars.

These 'critical success factors' are not purely military qualifications. In fact, they are a function of the scientific, economic, industrial, and political capabilities as well as the social cohesion of states. For example, the industrial base of a state, and the ability to mobilize this base, determines the amount of destructive potential that can be produced and deployed in a certain time span. Because successive systemic wars had become increasingly total during the unfolding of the singularity dynamic, the ability of the political leadership to mobilize populations and societies also became a critical success factor. To achieve 'total mobilization' to be able to fight 'total wars', states had to develop increasingly radical ideologies and military doctrines.

245 Free will is (mostly) an illusion.

KEY WORDS *second law of thermodynamics, War trap, Interacting self-fulfilling prophecies, Free will.*

In this study I explain how the second law of thermodynamics and other principles and mechanisms determine and, to a very high degree, shape the dynamics in the contingent domain of the System. The timing, duration, and severity of successive systemic wars, for example, were determined by the properties of the singularity dynamic as an outcome of the application of the second law of thermodynamics. The nature of non-systemic wars during relatively stable periods – chaotic or non-chaotic, depending on the numbers of freedom of the System – also was determined by a deterministic law that applies to the dynamics of the System.

States and their populations collectively produced the self-organized highly deterministic singularity dynamic through a multitude of their interactions. Although human decisions were necessary to produce systemic wars, the second law of thermodynamics 'determined' when the System reached the right conditions to produce these (and other) wars. The security dilemma, in combination with interacting self-fulfilling prophecies between states, ensured that the deterministic and contingent domains and dynamics were synchronized.

The deterministic nature of the dynamics and development of the System shows that, in a number of very relevant respects, free will was and still is an illusion. We unintentionally (and unknowingly until now) produced a self-organized highly deterministic finite-time singularity dynamic, of which we were an integral part; that then determined and shaped the interactions that sustained its development and unfolding. This is an example how interactions (between states and populations) and resulting self-organized macro structures (the finite-time singularity dynamic) interact and coevolve, and increasingly locked the dynamics of the System on a path of increasingly intense systemic wars.

Decision makers and populations in states unintentionally and unknowingly created a 'funnel' - a war trap - that determined and shaped their interactions, and by doing so further reinforced the war trap: the finite-time singularity dynamic is this war trap.

The four systemic wars the System produced during the 1495-1945 period through the singularity dynamic, had to emerge at the times they did; they were 'dictated' by the second law of thermodynamics and, as such, not a matter of choice. Only the contingent reasons for which they were fought were, at least to a certain degree, a matter of choice for states and their populations.

Free will is mostly an illusion. We are encapsulated in deterministic and highly path-dependent dynamics and structures; interacting self-fulfilling prophecies gave and still give us, the illusion that we make our own independent decisions (and keep some self-respect).

246 The school of Political Realism is an integral component of interacting self-fulfilling prophecies between states and populations that shaped and justified the deployment of ever-increasing amounts of destructive energy, consistent with the demands of the second law of thermodynamics.

KEY WORDS *Political Realism, Interacting self-fulfilling prophecies.*

The school of Political Realism is at the heart of the security dilemma and interacting self-fulfilling prophecies. It provided states and populations, in combination with ideologies they developed, with the justification to prepare for war and deploy destructive energy. Representatives of Political Realism do not leave much doubt about what international politics is about: international politics is about power. Political Realism is a normative doctrine for decision-makers of states, providing clear instructions for how to ensure their survival in an anarchistic system. Morgenthau and Kissinger are representatives of the school of Political Realism.

Political Realism, the anarchistic System, and the finite-time singularity the System produced during the 1495-1945 period are inseparably connected phenomena. The Realist school provided, and still provides, the 'scientific' justification and dogmas for decision makers of states to engage in increasingly intense wars. The school of Political Realism provide(d) decision makers of states with the decision rules they should obey to maximize their survival in an anarchistic System.

Political Realism provided – and still provides – states with the ability to create their own realities; the name 'school of Political Realism' could not have been more appropriate.

247 The School of Political Realism: Creating and exploiting self-fulfilling prophecies.

KEY WORDS *Political Realism, Interacting self-fulfilling prophecies.*

In an anarchistic system it is not difficult for a Realist to prove himself correct: he gets what he prophesies. Anarchistic systems never disappoint.

Political Realism does not qualify as science; it is a pseudo-science at best, an ideology that is exploited to justify the deployment of ever-increasing levels of destructive energy, and to give us a false impression of control. Political Realism is a glass ball that actually works, by successfully creating and exploiting interacting self-fulfilling prophecies between states (and their populations).

It is a serious concern that we are so easily misled by groupthink at such a scale; that we constructed and consistently acted on interacting self-fulfilling prophecies between states, that then locked us into an inescapable war trap, without experiencing any serious levels of cognitive dissonance.

248 So called 'Great Men in history' are highly contingent individuals, that share an ability to generate and harness tensions in the contingent domain of the System, and shape them to their own advantage; these 'great men in history', are however not the cause of wars they played a prominent role in on the contingent stage of the System.

KEY WORDS *Great Men, Interacting self-fulfilling prophecies.*

Wars are a 'product' of a combination of free energy that is produced in the anarchistic System, and the second law of thermodynamics that applies to this energy; wars are deterministic in nature.

This study shows that the four systemic wars the System produced during the 1495-1945 period, would have emerged 'anyway', at the same time (and with the same duration and severities) as they did.

The security dilemma and interacting self-fulfilling prophecies between states, would always ensure – also without the 'great men' the contingent domain put center stage, and we know for that reason – that the underlying deterministic dynamics and events that evolved in the contingent domain of the System would be synchronized.

Depending on the social issues etc. that were playing out in the contingent domain suitable 'great men of history' - that would meet the (specific) demands 'of the day' in the contingent domain – would – and will - always be found.

249 Implementation of increasing levels of order and, eventually of two dedicated non-anarchistic hierarchies in Europe following the fourth systemic war (the Second World War, 1939-1945), are not a matter of changes in human nature but of opportunistic accommodation.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Fourth systemic war, Dual-phase transition, Human nature, Survival.*

On four occasions during the 1495-1945 period, upgraded orders were implemented in the System; these upgraded orders allowed for lower energy states of the System and ensured that states could fulfill their basic requirements and survive in an increasingly connected System that produced increasing levels of tensions.

Ultimately in 1939, when the anarchistic System reached the critical connectivity threshold, the System produced a dual-phase transition through the fourth systemic war (the Second World War, 1939-1945) and two dedicated non-anarchistic hierarchies were implemented in the core of the System in Europe, and (at the same time) the first global order at a global scale of the System. The implementation of dedicated non-anarchistic hierarchies, a logical step in a longer-term process of integration in the contingent domain of the System, provided the basis for what eventually would crystalize into the European Union.

The highly deterministic finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) was self-organized, and was a product of the second law of thermodynamics that applied to the free energy (tensions) the anarchistic System produced. Increasing levels of order were so to say forced on the System by the second law of thermodynamics, and then could be used by states in the System to design and implement international orders that met their collective demands in the contingent domain of the System.

Implementation of international orders within conditions defined by the second law of thermodynamics was for states, essentially a matter of opportunistic accommodation. Upgraded orders with more favorable deterministic conditions for nodes with high centralities (dominant Great Powers) provided opportunities for these nodes to further stabilize the System and further consolidate and exploit their centrality, consistent with their interests. The design and implementation of increasingly integrated international orders, are not indicative of fundamental changes in the nature of humanity; they above all serve basic requirements and interests of states and their populations, to enhance their survival changes and quality of life.

250 During the 1495-1945 period, states had no other choice than to obey and sustain the unfolding of the finite-time singularity dynamic accompanied by four accelerating.

KEY WORDS *Singularity dynamic, Self-organization, Acceleration, Critical connectivity threshold, Collapse.*

The ever-increasing connectivity of the anarchistic System led to ever-increasing amounts of free energy in the System and an ever-increasing pace of life. Increasing amounts of free energy had to be put to work at accelerating rates. The finite-time singularity worked as an accelerating treadmill. To ensure the fulfillment of basic requirements and their survival and to avoid collapse, states and their populations and societies, had to keep pace with the accelerating singularity dynamic they had collectively produced.

The successive cycles that led to the System's unavoidable collapse once the critical connectivity threshold (the singularity in finite time) was reached in 1939, resembled an accelerating treadmill that states had to 'obey' and sustain to avoid stagnation and collapse. States, in other words, had no other choice than to keep pace with the accelerating finite-time singularity they had unintentionally and unknowingly created. Otherwise, their basic requirements would not be fulfilled and their survival would be at risk.

251 Despite the periodic and accelerating implementation of successive upgraded orders, the System produced free energy (tensions) at an increasing rate: Implementation of the first three upgraded orders, did not solve the intrinsic incompatibility between connectivity and security in the anarchistic System.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Free energy, Acceleration, Powerful-become-more-powerful effect, Collapse, Order, Dedicated non-anarchistic hierarchies.*

The intrinsic incompatibility between (increasing) connectivity and security in the anarchistic System led to the production of free energy (tensions in the contingent domain) in the System. Consistent with the second law of thermodynamics, the free energy (tensions) was periodically put to work to implement upgraded orders that allowed for lower energy states in the System. Lower energy states are required for more or less stable international orders.

Application of the second law of thermodynamics and other deterministic laws produced a finite-time singularity dynamic accompanied by four accelerating cycles, that unfolded during the 1495-1945 period in the anarchistic System.

Lower energy states in the deterministic domain were achieved by (re-) aligning the connectivity and destructive energy potential of dominant nodes as they had evolved during preceding relatively stable periods, with rule sets that reflected these centralities and defined interactions between these nodes (between states). In the contingent domain, lower tensions were achieved by implementing international orders that reflected the actual interests and power positions of dominant states.

Upgraded international orders were designed and implemented through systemic wars. Dominant states used their positions during systemic wars to include certain privileges in newly upgraded international orders that ensured that their interests and power positions would be promoted and that the status quo would be respected. Because privileges of dominant states were embedded in (new) international orders, dominant states had most to lose with a next update; the 'special interests' powerful states (increasingly) acquired in successive international orders, also contributed to the increasing structural stability of these orders. The dynamic between dominant powers and the successive international orders they designed and implemented produced a 'powerful-become-more-powerful' effect.

However, it was a matter of time before the anarchistic System would collapse: the accelerated growth rate of the frequencies and severities of successive systemic wars could not be sustained.

The anarchistic System collapsed when it reached the critical connectivity threshold (the singularity in finite time) in 1939. At that point it had become impossible for the System to produce viable upgraded orders in the anarchistic System, that could reconcile the intrinsic incompatibility between connectivity and security, and avoid the production of 'infinite' levels of free energy. In response, and consistent with the second law of thermodynamics, the System produced a dual-phase transition; the simultaneous implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a first global order with a global reach.

252 States and international orders coevolved.

KEY WORDS *States, International orders, Selection, Powerful-become-more-powerful effect, Coevolution, War trap.*

States, and successive international orders that were implemented at an accelerating rate through systemic wars, were both the products of the finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period.

States and international orders coevolved; they constitute complementary structures. States shaped international orders, while international orders shaped states as the component units of successive international orders.

Selection and self-organization were the mechanisms that were responsible for this coevolutionary process.

During the unfolding of the finite-time singularity dynamic, the System became critical and produced systemic wars at an accelerating rate. In order to ensure the continued fulfillment of basic requirements and to survive, states continuously enhanced their ability to produce and deploy increasing amounts of destructive energy. The state, with its particular characteristics and capabilities, was selected as the superior unit (organizational structure) that could best ensure the fulfillment of the basic requirements and the survival of its population. Selection of the state as the fittest unit led to the standardization of units in the System.

During the unfolding of the finite-time singularity dynamic (1495-1945), all units (constituting the anarchistic System) ultimately adopted state structures and continuously improved their ability to produce and deploy destructive energy, as demanded by the singularity dynamic.

Successive international orders that were designed and implemented by these increasingly standardized states, contributed to the developmental process of standardization and the continuously-improving war-fighting capabilities of states.

Because states became increasingly connected and interdependent, they also became increasingly dependent on a set of mutual agreed principles for international orders in the anarchistic System, to ensure their (increasingly mutual) security and the survival of their continuously increasing populations.

International orders were typically designed and implemented through systemic wars. Dominant states ensured (through their war fighting capabilities, and influence) that especially their (specific) interests were promoted and supported through these upgraded international orders. By doing so, the System developed a 'powerful-become-more-powerful' dynamic: dominant powers 'used' international orders (they implemented) to further reinforce their (already) dominant positions. This also implied, that dominant states had (increasingly) higher stakes in the maintenance of the status quo.

The increasing dominance of certain great powers made it impossible for other states to catch up and (also) achieve a great power position; great power status dynamics therefore came to a halt. The (increasing) permanence of a few great powers at the core of the System (Europe) and their increasing impact on successive international orders, contributed to the structural stability and robustness of the System.

The permanence of a few number of great powers (at least in the core of the System: Europe), their increasing impact on successive international orders that were designed and implemented, contributed to the structural stability and robustness of the System, and to the increasing levels of destructive energy the singularity dynamic required to destroy obsolete orders, and implement new – upgraded – orders.

The self-reinforcing dynamics of standardization, increasing war-fighting capabilities of states, increasingly comprehensive international orders that were implemented by increasingly powerful great powers, etc., were self-organized, became increasingly path-dependent, and locked the anarchistic System in an increasingly constraining and forceful war trap.

253 During the unfolding of the finite-time singularity dynamic (1495-1945), successive systemic wars became increasingly total in nature.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Totality of war.*

Through the finite-time singularity dynamic and consistent with the second law of thermodynamics, the anarchistic System demanded that systemic wars had to be produced at an accelerating rate, and with ever-increasing intensities/severities.

The finite-time singularity dynamic, accompanied by four accelerating cycles that unfolded during the 1495-1945 period can be considered a self-organized accelerating treadmill, that states produced by their accelerating and intensifying interactions; the pace of life of the System – as well as the production of free energy – continuously increased as consequence of the increasing connectivity of the System. 'Obedience' of the finite-time singularity dynamic by states and their populations, was required to ensure the continued fulfillment of their basic requirements and avoid collapse of the System. The System increasingly became a war trap.

The mobilization of all domains of states societies became necessary to support these efforts; warfare no longer was an event that only involved groups of mercenaries, in the periphery of societies.

Successive systemic wars progressively became more total, increasingly involving populations of states – and all domains of societies – in contributing to the (mass) production, mobilization and deployment of increasing amounts of destructive energy.

The increasing involvement of all domains of states and societies also implied that they became legitimate targets for adversaries; over time, wars became all-out efforts involving all domains of states and their societies, and putting to the test how they were politically and economically organized and could be mobilized. Successive systemic wars also became increasingly ideological in nature. Ideologies like nationalism, fascism, and communism, enabled mass-mobilizations and provided justifications for the use of extreme levels of destruction.

254 A damped oscillator constituted the first international order (1495-1618) of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945); the damped oscillator consisted of nine clusters ('orbits') of non-systemic wars, and is illustrative for the balancing properties of chaotic war dynamics.

KEY WORDS *Singularity dynamic, Cycles, Chaotic non-systemic war dynamics, Orbits, Balancing, Damped oscillator.*

During the first international order (1495-1618) the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) produced 45 non-systemic wars. When these 45 non-systemic wars are plotted in phase state defined by size (in terms of fraction) and their intensity, it is possible to distinguish nine circular trajectories, orbits.

Further analysis shows that the average sizes of non-systemic wars forming these nine orbits, develop very regularly; the average sizes of successive orbits behave as a damped oscillator.

These oscillations during the first international order are caused by the delayed corrective actions (in the form of clusters (orbits) of non-systemic wars) of the first international order (1495-1618) to reestablish an optimal equilibrium condition; the delays in these corrective actions caused respectively over- and undershoots. In case of the optimal equilibrium condition, that was eventually reached when the oscillations faded out shortly before the System became critical in 1618 and produced the first systemic war (the Thirty Years' War, 1618-1648), the security requirements of all states are satisfied; or – as was the case for the first international order – when non-systemic wars (the 'building blocks of corrective actions (orbits)) could not be produced any longer.

The reason the first (and other) international order(s) could at a certain point – shortly before the System became critical – not produce non-systemic wars any longer, was a result of the increasing impact of the connectivity/local stability effect on the non-systemic war dynamics. The connectivity/local stability effect started impacting the non-systemic war dynamics (and the sizes of orbits) in 1514 when the first international order reached its tipping point.

Successive orbits are – in other words – instrumental in the 'balancing' of the first international order. These highly regular and functional orbits are – I argue – the product of chaotic non-systemic war dynamics, that require at least three degrees of freedom ($n > 2$) to develop. A number of indications point to the chaotic nature of non-systemic war dynamics, if $n > 2$.

In case the System has only two degrees of freedom, as was the case during the first exceptional period (1657-1763), during the second cycle (1648-1815) of the finite-time singularity dynamic, as a consequence of the intense rivalry between Britain and France, the System did not produce orbits, but more extreme (in size and intensity) periodic non-systemic war dynamics instead.

These type of non-chaotic hyper-excited non-systemic war dynamics lacked the internal inhibition – an internal control mechanism – to produce regular orbits that could balance the international order: the damped oscillator is a manifestation of the balancing chaotic war dynamics can accomplish.

Analysis of the properties of non-chaotic non-systemic war dynamics during the hyper-excited first exceptional period (1657-1763) shows, that instead of 'controlled' orbits, the System produced two period 'sub-cycles'; each sub-cycle consisting of four non-systemic wars with intensities that grew at an accelerating (and thus unsustainable) rate. The second order produced these sub-cycles during the low-connectivity regime of the second cycle (1648-1815), when the sizes of non-systemic wars were not (yet) inhibited by a connectivity/local stability effect.

255 Systemic wars produce upgraded international orders.

KEY WORDS *second law of thermodynamics, Free energy, Upgrade, Order, International order.*

By putting free energy (tensions) to work through systemic wars, the anarchistic System upgraded its (international) orders, to allow for lower energy states of the System, consistent with the second law of thermodynamics. The production of accelerated amounts of free energy (tensions) in the anarchistic System contributed to an accelerating frequency of systemic wars, and order upgrades; during the unfolding of the finite-time singularity dynamic (1495-1945) the development of the System (also) accelerated.

Systemic wars consisted of three closely related and interacting activities: (1) the destruction of unresolved tensions and issues that accumulated in the System during relatively stable periods (international orders), (2) the design of upgraded collectively agreed-upon international orders, and (3) the implementation of these upgraded orders.

The deployment of destructive energy – war fighting – and alliance dynamics accompanied these three activities. By deploying destructive energy, unresolved issues and tensions were destroyed, bargaining positions of states regarding the 'design' of upgraded orders and their organizational arrangements established, and implementation of the upgraded arrangements assured.

The ability of states to successfully fight systemic wars and influence other states and alliances, determined to what degree upgraded orders could safeguard and promote their (specific) interests. More power and more influence of states – their dominance – implied stronger bargaining positions and the implementation of more favorable upgraded international orders.

Systemic wars can be considered collective system-wide 'planning' by states in an anarchistic system that are divided by competition and united by shared interests, including the need for collective security. States are driven by the same urge to survive, ensuring that upgraded orders that are established on one hand reflect and respect the uneven power and influence positions of states, and on the other hand ensure their collective fulfillment of basic requirements.

Due to the intrinsic incompatibility between increasing connectivity and security in the anarchistic System, it was however just a matter of time before the first three upgraded orders that were implemented (through the first three systemic wars) became dysfunctional, produced accelerating amounts of free energy, and were forced by the second law of thermodynamics to implement yet another upgraded order.

The implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe) through a dual-phase transition (the fourth systemic war, the Second World War, 1939-1945) brought an (unavoidable) end to this re-newel dynamic.

256 The purpose of international orders was (and still is) to 'reconcile' the intrinsic incompatibility between connectivity and security in anarchistic systems, and to ensure relative structural stability that enables the fulfillment of basic requirements by states in the System.

KEY WORDS *Intrinsic incompatibility, Free energy, second law of thermodynamics, Singularity dynamic, Acceleration, Critical connectivity threshold, Collapse, Dual-phase transition, Dedicated non-anarchistic hierarchies.*

Connectivity and security are intrinsically incompatible in anarchistic systems, and connectivity growth (as a consequence of population growth and rivalries between states in the System) resulted in the production of accelerating amounts of free energy (tensions) in the System. Consistent with the second law of thermodynamics, the free energy that amassed in the System was periodically put to work to implement upgraded orders that allowed for lower energy states of the System. The free energy (tensions) was put to work through systemic wars.

Application of the second law of thermodynamics to the free energy produced in the anarchistic System, resulted in the development and unfolding of a finite-time singularity dynamic accompanied by four accelerating cycles during the 1495-1945 period. The acceleration of cycles – each cycle consisting of a relatively stable period (international order), followed by a systemic war – was a consequence of the accelerating amounts of free energy that were produced in the anarchistic System. International orders that were implemented (through systemic wars) were only temporarily effective in 'restraining' the tensions (free energy) that unavoidably built up in the System; collapse of international orders in the anarchistic System was just a matter of time. The effectiveness of international orders determined if and to what degree states in the System (that had implemented the international order), could collectively fulfill their basic requirements. Through the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the anarchistic System ensured its performance (the collective fulfillment of basic requirements by uneven states in the anarchistic System), and evolvability (adaptation to the System's increasing connectivity).

However, at a certain point, when in 1939 the anarchistic System reached the critical connectivity threshold (the singularity in finite time), the System produced 'infinite' amounts of free energy (tensions), that could no longer be reconciled through an upgraded order in an anarchistic context. As a consequence, the anarchistic System collapsed and produced a dual-phase transition, consistent with the demands of the second law of thermodynamics. The dual-phase transition (the fourth systemic war, the Second World War, 1939-1945) resulted in the simultaneous implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and the first global order, at a global scale.

257 International orders always include arrangements that ensure the status quo. The fact that interests of the most powerful states are promoted by international orders contributes to the orders' structural stability.

KEY WORDS *Connectivity, Interdependence, International order, Powerful-become-more-powerful effect, Coevolution, Structural stability, Status-quo.*

International orders are the outcome of systemic wars when uneven states in the anarchistic System collectively design and implement upgraded orders that allow for lower tension levels in the anarchistic System. States in an anarchistic system have to find collective solutions that solve the paradox of increasing dependence on each other for the fulfillment of basic requirements, and, at the same time, increasing levels of tensions produced through their interactions.

Depending on their power, influence, and contribution to war fighting during systemic wars, states acquired more or less influential positions in the bargaining processes for design and implementation of upgraded international orders.

More influential – dominant – states could ensure that the upgraded international orders that were designed and implemented especially supported and promoted their own interests; they allocated privileges to themselves that were included in the organizational arrangements of international orders.

Because international orders (especially) served the interests of more powerful states, powerful states also ensured that the arrangements that defined international orders maintained the status quo; orders that were implemented by powerful states served them best.

Implementation of privileged international orders that served the most powerful and influential states best, and the fact that the same powerful and influential states were most effective in enforcing compliance with the international orders they implemented, contributed to the structural stability of (successive) international orders.

This 'mechanism' - the ability of more powerful states, to implement 'privileged' international orders - further strengthened their already powerful positions; I name this mechanism the 'powerful-become-more-powerful effect', that is inherent to the coevolution of states and successive international orders in anarchistic systems.

The 'powerful-become-more-powerful effect' had a positive impact on the structural stability of successive international orders. Successive international orders increasingly reflected the interests of a select number of powerful states, causing the orders to become *increasingly* stable and more robust. Increasing structural stability and robustness of successive international orders, contributed to the 'optimized' collective fulfillment of the basic requirements of all states in the anarchistic System.

258 The connectivity/local stability effect during high-connectivity regimes of international orders is responsible for the eventual criticality of the System.

KEY WORDS *Connectivity/local stability effect, Free energy release deficit, Crystallization, Criticality, Systemic war.*

Not only increased the 'overall' structural stability of the anarchistic System during the development and unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), but also during high-connectivity regimes of successive international orders. Once an international order reaches its tipping point, a high-connectivity effect starts to impact on the local stability of states in the System. This effect (increasingly) limits the sizes of non-systemic wars (non-systemic release events) the international order can still produce.

However, at the same time as the connectivity/local stability effect increasingly starts inhibiting the sizes of non-systemic wars during international orders, the production of free energy (tensions) in the System further accelerates. In other words, the same time as connectivity/local stability effect increasingly limits non-systemic release events (non-systemic wars), the System produces accelerating amounts of free energy (tensions).

Instead of being released, tensions and (unresolved) issues during high-connectivity regimes of international orders are 'stored' in the System, create a 'free energy release deficit', and crystallize in vulnerable issue clusters with fractal structures that eventually percolate the System, cause it to become critical and produce a systemic war. Consistent with the second law of thermodynamics, the 'stored' free energy (tensions) is put to work (released) during systemic wars to implement upgraded (international) orders, that allow for lower energy states (new stable periods) of the System. During high-connectivity regimes of international orders, the anarchistic System 'charges' itself for systemic war, and system-wide reorganization.

259 Although during the period 1495-1699 the Ottoman Empire/Turkey qualified as a Great Power, it was not a continuous member of the Great Power System, from which it selectively isolated itself (or was isolated).

KEY WORDS *Great Power status, Member System, Turkey.*

The Ottoman Empire/Turkey, considered a non-European state by Levy, had an ambivalent relationship with Europe and the European Great Power System. Turkey, located at the periphery of Europe, was not exclusively oriented towards European Great Power dynamics and did not fully integrate into the European System. It was able to selectively isolate itself from European Great Power dynamics, given its peripheral political and territorial position. This position – I argue – explains Turkey's absence during the first systemic war, the Thirty Years' War (1618-1648). The position of Turkey at the periphery of the European system also explains its - and Europe's -ambivalent position regarding Turkey's membership of the European Union.

260 Great Britain was the most influential European Great Power.

KEY WORDS *Britain, Great Power status, Powerful-become-more-powerful effect, Coevolution, Paradox.*

With the help of Levy's data set, it is possible to track the impact of certain Great Powers on the development of the System and on the development of successive international orders.

As I explained, the 'powerful-become-more-powerful' effect is at the core of the coevolution of states and successive international orders.

Levy's data (38) shows that during the unfolding of the finite-time singularity dynamic (1495-1945), Great Britain and France consistently possessed Great Power status.

Given the 'powerful-become-more-powerful' effect, and the coevolutionary nature of the development of states and successive international orders, I assume that Great Britain and France were the European Great Powers with the largest impact on the organizational arrangements of successive international orders of the anarchistic System, during the 1495-1945 period.

Until the second systemic war (the French Revolutionary and Napoleonic Wars, 1792-1945), wars (non-systemic and systemic) often concerned rivalries between Britain and France. During the third (1914-1918) and fourth (1939-1945) systemic wars (the First and Second World Wars), Britain and France cooperated with each other, to counter Germany, which threatened their interests and positions of dominance.

Because of Britain's role in the Second World War (the fourth systemic war, 1939-1945), avoidance of German occupation, and its close relationship with the United States, it not only had the largest 'overall' impact on the long-term development of Europe (1495-1945), but also on the political principles that were adopted for the establishment of the Western hierarchy (controlled by the United States).

The paradox is that Britain did 'win' the most with successive international orders that were implemented (1495-1939), but also lost most when eventually (through the fourth systemic war, the Second World War, 1939-1945) two dedicated non-anarchistic hierarchies were implemented in Europe, and at a later stage (1989) merged into one. Formal equivalence of states in Europe – 'democracy of states' – deprived Britain of its dominant position, that however was closely related to anarchy in Europe.

261 The United States' geopolitical position in the current global System (1945-...) resembles Great Britain's position during the period 1495-1939.

KEY WORDS *United States, Britain, Position, Periphery.*

Apart from size and other factors, Great Britain's island position at the periphery of the European System provided it not only with access to the seas, but also with superior natural defenses and the ability to selectively distance itself from Great Power politics on the continent. Access to the seas enabled Great Britain to exploit resources and markets outside of the European continent (colonies), that contributed to its power and influence.

In the current global System (1945-...), the (geopolitical) position of the United States in a number of respects resembles the position of Great Britain during the unfolding of the first finite-time singularity (1495-1945): The United States also is 'physically' - at least in some respects - 'isolated' from the rest of the World, is protected by vast oceans, and is simultaneously located at the periphery of Europe, as well as Asia.

262 Political principles that underpin the Western hierarchy especially reflect British principles, and are a manifestation of Britain's position of power and influence during the unfolding of the finite-time singularity dynamic (1495-1945). However, implementation of the non-anarchistic hierarchy implied that Britain lost this position, and qualifies from a British perspective in some respects as a Pyrrhic victory: A better world, but for Britain accompanied by loss of identity, power and status.

KEY WORDS *Britain, Western dedicated hierarchy, Power, Influence, Reluctance, Brexit.*

A number of 'inventions' that can be considered 'British', significantly impacted on political, economic and military developments, these 'inventions' include: capitalism (strong driver for expansion, war and colonialism, but also for scientific discoveries, industrialization, and mass production, including mass production of destructive energy), finance and insurance (enabler of capitalism), sovereignty and free use of the sea, spheres of influence, and power projection.

However, the dominant position that Great Britain achieved in the System during the unfolding of the finite-time singularity (1939-1945) came at a price. Although the Western hierarchy that was eventually implemented following the dual-phase transition (1939-1945), reflected British political and economic 'inventions', it brought an end to Great Britain's dominance in the anarchistic System. The non-anarchistic nature of the Western hierarchy (that at a later stage (1989) merged with parts of the Eastern hierarchy) brought an end to the anarchistic concept of 'dominance', and states became 'equivalent'.

For most European states, the end of anarchy and closer cooperation on the basis of equality meant progress and more influence. For Britain, on the other hand, it meant more meddling in what were traditionally considered exclusive British affairs or affairs Great Britain could, before implementation of the Western hierarchy, shape according to its specific interests.

Implementation of the Western hierarchy had its advantages for all involved, but, especially for Great Britain, also contained significant disadvantages.

The reluctance and unwillingness of Britain to fully embrace the European project, to share political power on an equal basis with other European states, and its 'exit' ('Brexit') from the European Union in 2016, are to a degree, a result of the loss of its dominant position, following the fourth systemic war (the Second World War, 1939-1945).

263 Ideologies were instrumental in the development and unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945).

KEY WORDS *Ideology, Survival, Singularity dynamic, Security dilemma, Interacting self-fulfilling prophecies.*

Ideologies contribute to the survival of individual humans and collective human structures by providing identity, enabling mass-mobilization, and (in case of the System) providing justification for the deployment of destructive energy against other collective structures and their ideologies.

Ideologies, in combination with political and military doctrines, were indispensable for the development of the finite-time singularity dynamic by shaping and fueling the security dilemma and interacting self-fulfilling prophecies between states, which ensured that dynamics in the contingent domain were synchronized with deterministic demands of the System.

264 Political ideologies and military doctrines enabled the development and unfolding of the finite-time singularity dynamic (1495-1945), whereas the singularity dynamic stimulated the further development of more radical ideologies and doctrines.

KEY WORDS *Singularity dynamic, Intrinsic incompatibility, Security dilemma, Interacting self-fulfilling prophecies.*

Wars do not just happen. Especially systemic wars, require planning, preparation, mobilization, and the support of populations and societies to enable a large-scale deployment of destructive energy. The security dilemma and interacting self-fulfilling prophecies, ensure that the deterministic demands (of the deterministic domain) and contingent dynamics in the contingent domain of the System are synchronized.

Political ideologies and military doctrines are also instrumental in the synchronization of both domains, and in ensuring, that states and their populations are mobilized in time, and can justify the efforts and sacrifices that must be made.

The increasing amounts of free energy (tensions) that were produced during the unfolding of the finite-time singularity dynamic (1495-1945), as a consequence of the intrinsic incompatibility between (increasing) connectivity and security in the anarchistic System, the increasing 'demands' of the finite-time singularity itself, for ever-increasing amounts of destructive energy, to ensure its further development and unfolding, and the development (in the contingent) domain of increasingly radical political ideologies and military doctrines, constitute a self-reinforcing dynamic. These are complementary components.

265 Clausewitz's war theory provided a rationale for the implementation of increasingly extreme military doctrines that justified the amounts of destructive energy that were deployed during the third and fourth systemic wars, the First and Second World Wars, respectively.

KEY WORDS *Clausewitz, Totality of war, Unfolding of the first finite-time singularity dynamic.*

Successive systemic wars, not only became increasingly total in the sense that all domains of societies of states and complete populations became involved in – and necessary for – preparations and the conduct of these wars, but also societies and populations became (as a consequence) legitimate targets. By explicitly linking war to politics, and to the survival of the state, Clausewitz contributed to the necessary and unavoidable totality of systemic wars, and to the 'undisturbed' unfolding of the finite-time singularity to its final conclusion in 1939.

266 Our acceptance of incomplete and unfounded explanations for wars and war dynamics in the System, are illustrative of our limitations, but also of our flexibility to create our own realities.

KEY WORDS *Singularity dynamic, War trap, Security dilemma, second law of thermodynamics, Interacting self-fulfilling prophecies, Flexibility, Cognitive dissonance.*

Although states could always justify wars as "mere continuations of policy by other means," (19) they were not aware that these wars were in fact energy releases in the System produced by a self-organized finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945). The finite-time singularity dynamic was unintentionally produced by a multitude of interactions between states and populations in the System. States were not aware that that the singularity dynamic increasingly shaped and determined these interactions, creating more tensions that further fueled the development and unfolding of the finite-time singularity dynamic. The singularity dynamic created a funnel towards infinite war and constituted a 'war trap'.

The undisturbed unfolding of the finite-time singularity dynamic (1495-1945) shows that states and the anarchistic System were consistently able to produce enough destructive energy at exactly the right time, to comply with the second law of thermodynamics.

The security dilemma, interacting self-fulfilling prophecies between states (mechanisms contributing to the synchronization of the contingent and deterministic domains of the System), that were 'powered' by increasingly extreme political ideologies and military doctrines, ensured that states and their populations and societies, were always able to justify wars and the increasing amounts of destructive energy that had to be deployed, at exactly the right time. The timings of wars were (and are) determined by physical laws that apply to the energy (tensions) in the System.

The fact that states, populations and societies did not realize that wars were mere deterministic releases of free energy that complied with the second law of thermodynamics, is indicative of our inability to recognize this, but at the same time is a manifestation of our flexibility to justify whatever war effort the System, governed by the second law of thermodynamics, requires from us. Wars were never 'canceled' because armies failed to turn up; interacting self-fulfilling prophecies ensured this.

It is also a worrying illustration of our limitations (and 'boundless' flexibility) that historians and politicians were always able to convincingly explain why wars had happened as they did (72). A lack of consistency in these explanations and a lack of any basic understanding of the System's workings, as discussed in this study, never caused any significant levels of cognitive dissonance or distrust.

267 Political Realism generates collective self-fulfilling prophecies and makes optimal use of collective human self-deception.

KEY WORDS *Political Realism, Clausewitz, Security dilemma, Interacting self-fulfilling prophecies.*

The insights this study provides into the workings of the System show and explain the essential role the Realist School in played for the unfolding of the accelerating finite-time singularity dynamic.

Realist 'logic' is at the core of the security dilemma and assumes that international politics is about power and that power should be applied to enhance the state's interests. These ideas shaped interactions between states and contributed to the build-up of tensions in the System. Realist logic was also responsible for shaping interacting self-fulfilling prophecies between states. These interacting self-fulfilling prophecies ensured that states could always justify and make sense of their actions and reactions regarding other states.

Because of the rules that govern anarchistic systems and the mechanisms these rules produce, including the security dilemma and interacting self-fulfilling prophecies, Realist logic never disappoints. If, for example, a state preventively deployed destructive power in response to a security issue with another state, its threat perception would be confirmed by the reaction of the other state. The target state, obeying the security dilemma and supported by 'its own' interacting self-fulfilling prophecies, would take adequate counter measures by also deploying preventive destructive energy. In an anarchistic System, preventive deployments of destructive power provoke reactions by other states that confirm the initial deployment. An anarchistic System confirm a state's worst expectations.

During the unfolding of the finite-time singularity dynamic (1495-1945), decision makers saw their worst assumptions always confirmed and considered their self-fulfilling experiences wise lessons for similar situations in the future, further reinforcing the Realist war-trap logic.

The members of Realist School (including Morgenthau, Kissinger, etc.), as well as Clausewitz (19), were products of the finite-time singularity dynamic, and vice versa; they were necessary enablers of the unfolding of the accelerating finite-time singularity dynamic. It was through these theories that the dynamics of the anarchistic system connected with the decision makers who had to decide on war. These theories did what they were supposed to do. The result shows humanity's unbounded flexibility and creativity for creating structures and defining logics within these structures that make sense to us. The urge to survive is not only strong, but also creative.

268 The logic of war decisions has not changed over time.

KEY WORDS *Singularity dynamic, Consistent decision making.*

The finite-time singularity accompanied by four accelerating cycles (1495-1945) developed and unfolded, apart from a deterministic distortion during the exceptional period (1657-1763), in a remarkably regular pattern. Despite numerous changes in the System during this period, including changes in the structure of units (states), ideologies, and technology, units (states) consistently applied the same basic logic to war decisions. War decisions were, and can still be, defined as binary decisions with externalities and thresholds. This consistency explains (and is a precondition for) the regular development and unfolding of the finite-time singularity dynamic (1495-1945).

269 Religions are powerful organizers.

KEY WORDS *Religion, Tensions, Middle East, Africa, Basic requirements.*

Religions (also) are effective in controlling (the production of) tensions in social systems, besides giving meaning, etc.

Recently, a number of states in Africa (Libya) and the Middle East (Iraq, Syria, Yemen) collapsed or almost collapsed; these states lacked sufficient balance, and as a consequence their integrative structures lost legitimacy, and/or could no longer compensate their lack of legitimacy through (what qualifies as) suppression. The fact that state-structures were 'designed' to ensure the fulfillment of basic requirements of populations in Europe – a long-term process of development – and were imposed on 'territories' in above mentioned regions, also contribute(d) to their lack of viability.

Furthermore, in those regions an alternative is available: religion (Islam), that provides populations with a strong concept of organization. Given the poor record of states in these regions, this alternative is tested by populations, and competes with state structures; especially when arrangements of state-structures conflict with the interpretation of religion.

Religion provides practical organizing principles to fulfill basic requirements, including a justice system, meaning, and individual and collective identities. In these regions, state-structures were (and often still not are) effective.

270 Supported by longer-term social and technological developments, war has become increasingly individualized and customized. States are no longer the exclusive unit of war.

KEY WORDS *Social development, Technological development, States, War, Destructive energy, Nature of warfare.*

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), successive systemic wars 'necessarily' had become more total to ensure that sufficient amounts of destructive energy could be produced, mobilized and deployed against other states. During this process, the increasing involvement of populations and all domains of societies of states, went hand in hand with increasing political empowerment of these populations, to ensure their support of the state. Empowerment of populations, and of 'groups' and individuals, was further stimulated by technological innovations, for example the Internet.

Following the dual-phase transition (the fourth systemic war, the Second World War, 1939-1945), the last phase of the finite-time singularity dynamic, and the collapse of the Eastern hierarchy (1989), war developed from (1) inter-state wars, (2) to confrontations (wars) between states and populations (the Vietnam War for example, 1965-1973), (3) to wars that mainly involve different groups in sates ('war amongst the people', Iraq, Syria), (4) to wars (acts of violence) increasingly involving communities and individuals against states and populations, or (5) various combinations of 1-4; wars seem to have become more hybrid.

War – the form of wars – has increasingly become 'individualized' and 'customized' to meet the specific demands of (cross-border communities) and individuals.

271 Structural developments in the System, including the weakening of state structures and the simultaneous empowerment of communities and individuals, will impact the nature of war and the war dynamics of the System, as well as its long-term development.

KEY WORDS *State structures, Empowerment, Nature of warfare, second law of thermodynamics, Connectivity, Network-of-networks.*

The weakening of states structures, and the (simultaneous) empowerment of communities and individuals are related developments. The question is how this interacting dynamic will eventually play out: will state-structures be reinforced, or will they further fragment, and be replaced by cross-border communities? Eventually, the outcome will be decided in favor of the structure – states or communities ('networks of networks') – that ensures the most effective and efficient fulfillment of basic requirements of populations, including their security.

I assume that the formation ('crystallization') of network (community) structures is reinforced during relatively stable periods, and that tendencies towards the formation of state-structures is reinforced during systemic wars. Connectivity growth drives this dynamic. The second law of thermodynamics will 'decide' what structure is most effective in limiting the production of free energy in the System, and allowing for a lower energy state.

In Europe, the first singularity dynamic (1495-1945) was instrumental in transforming a sizeable collection of divers and loosely connected units (1495), into a highly connected and coherent system consisting of a low number of highly standardized states (1939), and eventually in two dedicated non-anarchistic hierarchies (1945). A second finite-time singularity dynamic (1945-...), that is now developing and unfolding, could – I speculate – transform the current global anarchistic System of states into a network of communities, for the simple reason, that such a 'network of networks' is better able to fulfill the basic requirements of populations and these communities, and ensure a lower energy state of the System (assuming a number of conditions in the contingent domain are met). By exploiting the Internet and global mobility, networks of communities are (better) able to exploit economies of scale and scope (for their 'own' specific purpose), while maintaining a certain balance.

272 States cannot respond effectively and proportionally to terrorist attacks ('from within').

KEY WORDS *Singularity dynamic, Terrorism.*

States – a product of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) – are not designed and equipped to counter terrorism and fight a 'war from within'. The 'enemy from within' consist of individuals and small networks (communities), that are integral parts of the state and society they want to undermine and destroy.

States are designed to fight other states. Armies, navies and air forces are designed and organized to fight their counterparts of other states; their optimized (fractal) structures (that developed over time during the unfolding of the finite-time singularity dynamic, 1495-1945) reflect this. Armies cannot gather accurate information about the 'enemy from within', nor accurately target the enemy; they do not have suitable capabilities to achieve this. Confronted with terrorism, states often are caught off guard.

It is the aim of these terrorist communities to set a self-reinforcing dynamic in motion, through which states and societies ultimately destroy themselves; they try to trigger such a self-destructive response by acts of terror.

By randomly targeting civilians, and targeting representatives of the state, terrorists spread fear, and provoke responses of the state that undermine its legitimacy and cause (further) frustration in society.

As is the case with guerilla warfare – like terrorism a form of warfare that shares some similarities – in case of an enemy from within, society must be mobilized and get involved, not only to prevent individuals from becoming radicalized, but also to prevent these individuals and communities from conducting terrorist attack. The deployment of armies cannot be effective, and can undermine the legitimacy of the state. Networks have to be fought by networks.

273 Increasing empowerment of individuals and communities contributed- and still contributes - to the increasing totality of war.

KEY WORDS *Empowerment, Totality of war, Fourth systemic war, Internet, Social media.*

States that are better able to leverage the capabilities of their populations and their synergetic interactions (leveraging 'more' economies of scale and scope) improve their ability to fulfill basic requirements and by doing so also improve their survival changes.

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), a trend towards increasing totality of (especially) systemic wars can be observed. Increasing totality of war was the outcome of efforts of states to improve and optimize the usage of their capabilities, to meet the 'demands' of the unfolding finite-time singularity dynamic. This trend – the mobilization of additional resources and capabilities in populations and societies – continued after the fourth systemic war (the Second World War, 1939-1945).

These efforts also led to the increasing empowerment of individuals and communities, the building blocks of populations and societies, in not only a political sense (acquiring suffrage), but also in their practical ability to organize and exploit initiatives. A number of more recent technological (the Internet) and (accompanying) social innovations (social media) also contributed to the further empowerment of individuals and communities.

Starting in 1989, when the Eastern hierarchy collapsed and the second exceptional period (1953-1989, the Cold War) came to an end, the System resumed chaotic war dynamics; as a consequence, the empowerment trend received an extra stimulus. The further empowerment of individuals and communities contributed to the development of new 'concepts' of warfare, in which individuals and communities become active 'players'. These new 'actors', make use of the Internet, social media and global mobility to inspire and recruit individuals and communities, to deploy destructive energy at a global scale, to achieve their objectives, and undermine the current System.

274 The development of war-fighting doctrines from attrition to maneuver warfare, during the third and fourth systemic wars, respectively (the First and Second World Wars, 1914-1918 and 1939-1945) was enabled by the increased empowerment of subunits and individuals, and can be considered precursors to hybrid and community warfare, that emerged at a later stage.

KEY WORDS *War-fighting, Attrition warfare, Maneuver warfare, Systemic war, Hybrid warfare, Community warfare, Precision targeting.*

During the unfolding of the third and fourth cycles of the finite-time singularity dynamic (covering the period 1815-1945), warfare developed from what is also called 'attrition warfare' (during the third systemic war, the First World War, 1914-1918) to 'maneuver warfare', during the fourth systemic war, the Second World War, 1939-1945.

Attrition warfare is characterized by the mass-deployment of centrally controlled mass-armies to cause mass destruction; in case of maneuver warfare on the other hand, there is decentralized control accomplished through a shared understanding of the (war) objectives and enabled by the use of wireless communication technology.

In case of maneuver warfare, the ability of the enemy to fight is targeted, if possible by avoiding direct confrontations (and costly attrition). In case of maneuver warfare, sub-unit commanders are stimulated to exploit local circumstances on the battlefield. Maneuver warfare is a precursor to 'hybrid and community warfare'; 'hybrid' refers to the diversity in actors that participate in these wars (from states to communities, and individuals), whereas 'communities' refers to the role networks (communities) play.

In case of respectively attrition-, maneuver- and hybrid/community-warfare, wars became increasingly total, in the sense of the 'resources' that are deployed (including communities and individuals 'outside of', or 'super-imposed on' states), the choice of targets (state-functions, but also communities and individuals), but not necessarily in the total amounts of destructive energy that is deployed; there is more precision targeting; wars are now (also) fought 'within' the fabric of societies.

275 'Scaling up' (leveraging complete societies and their capabilities) and 'scaling down' (empowerment of communities and individuals) are two dimensions of a process (a trend) of wars becoming increasingly total.

KEY WORDS *Dimensions, Totality of war, Scaling-up, Scaling-down, Empowerment, Reinforcement, Network-of networks.*

Scaling up – increasingly leveraging complete societies and their capabilities to maximize the deployment of destructive energy of states – and scaling down – the increasing empowerment of communities and individuals to contribute to, or fight their own, wars – are two dimensions of a trend of wars increasingly becoming total.

Both 'dynamics' (scaling up and down) reinforced each other; they are two sides of the same coin. States initially scaled up by leveraging their populations and societies as can be observed during the second systemic war (the French Revolutionary and Napoleonic Wars, 1792-1815) when conscription was introduced. This one sided approach, exclusively focusing on scaling up, reached its most extreme application during the third systemic war (the First World War, 1914-1918). During this systemic war, states mobilized their populations and deployed massive amounts of destructive energy resulting in mass destruction.

The limitations of this approach, and efforts of states to further maximize their destructive potential, resulted in more scaling up, but also in scaling down: the empowerment of subunits and individuals to exploit their capabilities. Ideologies were instrumental in both scaling up and scaling down.

The next phase of this process is further scaling down, when communities and individuals develop(ed) themselves as independent actors (not linked to states), and start(ed) their 'own' wars, to accomplish their own ambitions and objectives.

Technological and social innovation are enablers of this process.

Further scaling-down could (also) 'force' the System to eventually develop towards a global 'network of networks', instead of a system consisting of states (as we now know them) as its primary building-blocks.

276 Despite some fundamental differences in the organization and procedures of decision-making processes of states regarding war, at their core these processes are identical, and in all cases qualify as binary decisions with externalities and thresholds.

KEY WORDS *Decision making, Binary decisions with externalities and thresholds.*

In his study "*The Sleepwalkers, How Europe went to War in 1914*" Clark discusses differences in decision-making processes and procedures in governments of states preceding the outbreak of the First World War: "A very cursory look at the governments of early twentieth-century Europe reveals that the executive structures from which policies emerged were far from unified (18). Policy-making was not the prerogative of single sovereign individuals. Initiatives with a bearing on the course of a country's policy could and did emanate from quite peripheral locations in the political structure. Factional alignments, functional frictions within government, economic or financial constraints and the volatile chemistry of public opinion all exerted a constantly varying pressure on decision-making processes. As the power to shape decisions shifted from one node in the executive structure to another, there were corresponding oscillations in the tone and orientation of policy. This chaos of competing voices is crucial to understanding the periodic agitation of the European system during the last pre-war years."

Although states differ in the rationalities they create through interacting self-fulfilling prophecies to justify war decisions, and (war) decisions are influenced by different interests, and ambitions of decision makers, at the core, 'all' war decisions are identical. Ultimately, all these processes and procedures (of different states) converged on just a single binary question: 'war' or 'no war'; and (inter-) actions of other states to a very high degree determined decisions that were made.

At their core, all the diverse decision-making processes and procedures qualify as binary-decisions with externalities and thresholds.

277 When war is considered unavoidable, a 'war-logic' starts dominating decision-making processes and causes an acceleration toward war.

KEY WORDS *War-logic, Critical point, Principles of war.*

Clarke describes the final stage (in the contingent domain), when the outbreak of the First World War became unavoidable as follows: "... a kind of temporal claustrophobia that we find at work in the reasoning of many European statesmen of this era - a sense that time was running out, that in an environment where assets were waning and threats were growing, any delay was sure to bring severe penalties" (18).

This typical dynamic can be explained with the insights provided by this study. Although the buildup of tensions during relatively stable periods constantly accelerates, once the tipping point is reached, and the System is in a high-connectivity regime, the sizes of non-systemic wars are increasingly inhibited. At that stage, instead of being released, tensions are increasingly 'stored' in the System, and crystallize into vulnerable issue clusters with fractal structures, that eventually percolate the System, cause it to become critical and produce a systemic war (to implement an upgraded order that enables a lower energy state of the System).

When the System reaches the critical point (becomes critical), the System has become highly susceptible for perturbations; at the critical point the correlation length of the System has become 'one', a condition that enables for system-wide communication, coordination and planning.

Clark's description of this 'final' moment – when the critical point is (about to be) reached – shows how decision makers of states are overwhelmed by incoming signals, they cannot make sense of anymore. Because of the correlation length of one, events and incidents cannot be understood – made sense of – in 'isolation'; the System now is fully connected, including its issues. Even interacting self-fulfilling prophecies of states cannot keep pace with developments in the System.

This closing in of tensions and threats – as it is experienced by decision makers – made decisions makers see only one way out: war.

Once a sense that war has become unavoidable is reached, another logic starts dominating decisions-making processes; wars and war-fighting have their own logic.

War-fighting (conditions) can be more favorably shaped when states take the initiative 'on the battlefield', and do not wait for an unavoidable attack (that is the perception) by another state(s). A military and (for that reason) political premium rests on the offensive; offensive action forces the adversary to react and deprives him of freedom of action.

Principles of war stress the importance of 'initiative', 'offensive action' and 'surprise', because application of these principles not only provide advantages on the battlefield, but also to politicians in the bargaining processes that accompany (systemic) wars. These advantages ultimately result in the design and implementation of an upgraded order. "War is a mere continuation of policy by other means" (19).

278 Successive international orders increasingly reflected British interests and values.

KEY WORDS *International orders, Powerful-become-more-powerful effect, Power, Influence, Britain, Paradox, Brexit.*

As a result of the 'powerful-become-more-powerful' effect and the increasing structural stability of the System, successive international orders increasingly reflected British interests. Great Britain was consistently in a position to have a dominant impact on the arrangements of the international orders that were designed and implemented through successive systemic wars. The System increasingly became a British System; a reflection of British interests and values.

However, a paradox that until today affects British and European politics, the ultimate phase transition – resulting in the implementation of a dedicated hierarchy in Western Europe (of which Britain was an integral part) and the integration of parts of the collapsed Eastern hierarchy in 1989, – actually diminished Great Britain's position of power and influence in Europe.

Because of the principles Britain promoted, the (Western) hierarchy also is democratic and capitalist in nature and (as a consequence) in design. The democratic hierarchy that was implemented, deprived Britain of its power and influence and explains British reluctance to join the European Community in the first place, its continued skepticism about the European Union and its arrangements, and its Brexit-vote in 2016.

In the Western hierarchy – and in the European Union – power and influence are shared but also diluted. Britain had – and that is the paradox – most to lose by the implementation of the Western hierarchy (later European Union), while other states had more to win. Britain became a victim of its own success.

The shortcomings of the integrative structures of the now extended dedicated non-anarchistic hierarchy – the European Union – are evident and restructuring is urgently required; a British exit however will not solve Britain's problems: Europe is too integrated – interdependent – to allow for independent politics and (inter) sanctions by Britain (and other states). Nostalgia is not a good counselor in an increasingly connected – and continuously changing – System.

279 Great Britain simultaneously dominated and shaped the process of integration and expansion.

KEY WORDS *Singularity dynamic, Core, Non-core, Britain, Integration, Expansion.*

During the unfolding of the finite-time singularity dynamic, Britain's island position at Europe's periphery provided Great Britain with a favorable position in regards to (1) the core of the System (a natural defense, not surrounded by potential adversaries), and (2) the non-core of the increasingly globalizing system (free access to the seas and (potential) colonies. By developing and leveraging this double advantageous position, Great Britain created a dominant position in Europe (the core of the System) and in its non-core. Great Britain decisively dominated and shaped the simultaneous process of integration of the core (Europe) and expansion outside Europe to the non-core.

16 PATH DEPENDENCE AND LOCK-IN

280 States and international orders coevolved.

KEY WORDS *Coevolution, Units, States, International orders, Powerful-become-more-powerful effect, Collapse, Critical connectivity threshold.*

Initially, at the inception of the singularity dynamic (1495), the System consisted of a large number of diverse and loosely connected units. Over time, during the unfolding of the singularity dynamic (1495-1945), not only did the number of units dramatically decrease, but they also developed into highly connected and highly standardized state structures that were especially equipped to produce, mobilize, and deploy destructive energy to ensure their survival in the anarchistic System.

During the unfolding of the singularity dynamic, units (states) were confronted with ever-increasing levels of tensions, and systemic wars were produced with accelerating frequencies and severities (amplitudes), as a consequence. States and international orders that were produced by successive systemic wars coevolved. International orders produced through systemic wars were arranged to restrain the production of tensions and create the structural stability necessary for the fulfillment of basic requirements of states. Especially powerful states were in a position to decide on the arrangements of international orders; by leveraging their dominant positions, these powerful states ensured that international orders promoted their specific interests. In fact, the co-evolutionary dynamic involving states and international orders was to a high degree shaped by what I name a 'powerful-become-more-powerful' effect. Powerful states could insist that favorable arrangements would be embedded in successive international orders; by doing so, these already powerful states further consolidated and reinforced their positions, enabling them to increase their influence during the next relatively stable period(s) and systemic war(s).

Thus, whereas states were forced to maximize their capabilities to produce, mobilize, and deploy destructive energy because of the increasing levels of free energy (tensions) produced by the System, successive international orders became increasingly comprehensive in their arrangements in efforts to restrain the production of these tensions. These efforts however ultimately failed; the anarchistic System could not keep up with the growing rates of free energy production in the intrinsically incompatible anarchistic System, and collapsed when the anarchistic System reached the critical connectivity threshold.

281 The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) was a path-dependent dynamic that pushed the System towards more order and further integration.

KEY WORDS *Intrinsic incompatibility, Connectivity, Security, Anarchy, second law of thermodynamics, Free energy, Critical connectivity threshold, Deterministic domain, Contingent domain, Path dependence, Lock-in.*

Because of the intrinsic incompatibility between increasing connectivity and security in anarchistic systems, over time the System produced increasing amounts of free energy (tensions). Consistent with the demands of the second law of thermodynamics, this free energy was periodically put to work to implement upgraded orders that better restrained the free energy and allowed for a lower free energy state in the System.

Upgraded orders had to be implemented at an increasing rate, and increasing levels of destructive energy had to be deployed to destroy obsolete orders and design and implement these new orders. Ultimately, the singularity dynamic could not keep up with the increasing levels of free energy that were produced by the anarchistic System. When the System reached the critical connectivity threshold in 1939, it collapsed, and through the fourth systemic war that followed (the Second World War, 1939-1945), dedicated hierarchies were introduced into the core of the System (Europe). Anarchy was neutralized within these dedicated hierarchies, resulting – at least temporarily – in a lower energy state of the System, consistent with the demands of the second law of thermodynamics.

The upgraded orders that were periodically implemented in the deterministic domain of the System – as just described – facilitated the implementation of increasingly comprehensive organizational arrangements – international orders – between states in the contingent domain. The development of upgraded orders in the deterministic domain went hand in hand with the integration of states and the System in the contingent domain (and in fact constitute the same integrated dynamic).

The finite-time singularity dynamic accompanied by four accelerating cycles qualifies as a self-reinforcing path dependent dynamic – ultimately resulting in a lock-in – that produced increasingly high levels of order and integration. The direction of development of the singularity dynamic towards increasing levels of order and integration was already contained in its initial conditions.

282 Path-dependency is not only a characteristic of the finite-time singularity dynamic accompanied by four accelerating cycles that developed and unfolded in the deterministic domain of the System during the 1495-1945 period, but is also a characteristic of its counterpart in the contingent domain.

KEY WORDS *Deterministic domain, Contingent domain, Singularity dynamic, second law of thermodynamics, Systemic war, Order, International orders.*

The second law of thermodynamics and a number of other mechanisms in the deterministic domain produced a path-dependent finite-time singularity accompanied by four accelerating cycles (1495-1945) that locked-in on increasing levels of order in the System, to 'restrain' the production of free energy (tensions). Increasing levels of order were implemented during the periods of criticality that the System produced at an accelerating rate during the unfolding of the singularity dynamic.

These increasing levels of order that ultimately resulted in a phase transition when, in 1939, the critical connectivity threshold was reached and the System implemented dedicated non-anarchistic hierarchies in its core (Europe), have contingent counterparts: increasingly comprehensive organizational arrangements that were implemented through successive systemic wars in the form of successive international orders.

The first systemic war (the Thirty Years' War, 1618-1648) resulted in the implementation of the 'sovereignty principle', determining that each 'recognized' state has sovereignty over its domestic affairs to the exclusion of all external powers, that states are not allowed to interfere in another state's domestic affairs, and that each state is equal in international law. The second systemic war (the French Revolutionary and Napoleonic Wars, 1792-1815) built on the sovereignty principle and led to the 'Congress of Vienna' (1815-1914). The Concert of Europe represented the balance of power that existed in Europe. It had no written rules or permanent institutions, but member states could propose conferences to discuss and solve issues that concerned the balance of power of Europe. The third systemic war (the First World War, 1914-1918) resulted in the introduction of the League of Nations (1920, formally dissolved in 1946) and constituted the next step in the contingent process of further integration of the System. The League of Nations also included states and Great Powers from outside of Europe. It was an intergovernmental organization with permanent institutions. The goal of the League of Nations was to prevent war through disarmament, negotiation, and arbitration. It could impose sanctions on states to force them to comply with the League's goals. Nevertheless – despite these arrangements – it was just a matter of time before the fourth international order (1918-1939, the League of Nations) also collapsed (1939), as a consequence of the ever-increasing amounts of free energy (tensions) the anarchistic System produced and had to 'store'.

At the same time as free energy (tensions) was produced in infinite amounts (1939), the 'infinite' robustness of the anarchistic System prevented the release of free energy (tensions) through non-systemic wars: the anarchistic System was now no longer viable and collapsed as a consequence.

In response, and consistent with the second law of thermodynamics, the System through the fourth systemic war (the Second World War, 1919-1945), implemented (1) two dedicated non-anarchistic hierarchies in the core of the System (Europe), that at a later stage (1989) 'merged', and formed in what would eventually become the European Union, and (2) the first global order; the United Nations, at a global scale of the System.

The path-dependent nature and lock-in of the finite-time singularity dynamic (1495-1945) resulted in the implementation of successive upgraded orders that were increasingly stable and robust (but also short-lived); ultimately (1939-1945) two dedicated non-anarchistic hierarchies were implemented in the core of the System (Europe). This deterministic dynamic was 'synchronized' with an equivalent and also path-dependent and locked-in integrative dynamic – its counterpart – in the contingent domain of the System, which eventually led to the European Union (the latest European order) and the United Nations (the first global order).

283 During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), states increasingly locked in on their ability to produce, mobilize, and deploy ever-higher levels of destructive energy.

KEY WORDS *Singularity dynamic, Coevolution, Acceleration, Lock-in, Powerful-become-more-powerful effect, Selection, Warfighting.*

As a consequence of the intrinsic incompatibility of connectivity and security in anarchistic systems during the unfolding of the finite-time singularity (1495-1945), the System produced free energy (tensions) at an accelerating rate.

Consistent with the demands of the second law of thermodynamics, the free energy – tensions – was periodically put to work through systemic wars, to produce upgraded orders that allowed for lower energy states – new relatively stable periods – of the anarchistic System.

In the contingent domain of the System, tensions (free energy) were put to work through systemic wars; during systemic wars, states collectively destroyed 'dysfunctional' issues and tensions, and designed and implemented upgraded international orders.

Because of the accelerated growth rate of tensions, the anarchistic System became critical and produced systemic wars at an accelerating pace, and with accelerating intensities/severities.

Ultimately, when in 1939 the anarchistic System reached the critical connectivity threshold (the singularity in finite time), the System produced infinite amounts of free energy that led to the collapse of the anarchistic System and a phase transition (1939-1945, the fourth systemic war, the Second World War) that led to the simultaneous implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a first global order, at a global scale of the System.

The finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period, was a self-organized emerging macro dynamic, produced by a multitude of interactions between states. The singularity's performance – its ability to fulfill basic requirements of uneven states in an anarchistic System – and evolvability – its ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars – were highly optimized.

The unfolding of the finite-time singularity dynamic that produced systemic wars with accelerating frequencies and accelerating intensities/severities also qualifies as a highly path-dependent dynamic.

Path-dependency and the resultant lock-in were achieved through a selection mechanism that shaped the coevolutionary development of certain properties of states and the international orders, these states designed and implemented through systemic wars.

Selection worked at two levels: (1) it shaped units – states – through their mutual interactions, that were – because of the anarchistic nature of the System – often (and increasingly) competitive and hostile in nature, and (2) shaped the coevolutionary dynamics between certain properties of states and of successive international orders they collectively (but not on equal terms) produced.

Dominant Great Powers could use their positions during systemic wars to implement international orders that (especially) ensured their interests; the interaction between powerful states and successive international orders produced a 'powerful-become-more-powerful' effect. This was a self-reinforcing mechanism. This effect, in combination with the fact that the ability of states to produce, mobilize, and deploy free energy increasingly became a trait that determined their survival, enabled the System to sustain the unfolding of the finite-time singularity dynamic until free energy and tensions were produced at infinite levels (1939).

Thus, through self-organization and selection, fueled by ever-higher levels of free energy that were produced as a consequence of the increasing incompatibility between (increasing) connectivity and security, the anarchistic System produced states that for their survival became increasingly dependent on their war-fighting capabilities.

284 Not only did the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) constitute a highly path-dependent dynamic that produced a lock-in on the production, mobilization, and deployment of ever-higher levels of destructive energy, it also produced a path-dependent dynamic and lock-in on the implementation ever higher levels of order and on the implementation of two dedicated non-anarchistic hierarchies in Europe, and a first global order at a global scale of the System.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Acceleration, Critical connectivity threshold, Collapse, Dual-phase transition, Dedicated non-anarchistic hierarchies, SIE.*

As discussed, an finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) locked the development of states in the anarchistic System in on their ability to produce, mobilize, and deploy ever-larger amounts of destructive energy. These path-dependent developments ensured the development and unfolding of the finite-time singularity dynamic.

Consistent with the second law of thermodynamics, the free energy (tensions) the System produced was periodically put to work through systemic wars, to implement upgraded orders that allowed for lower energy states of the System.

Because of the accelerated growth of free energy (tensions) in the System, upgraded orders had to be implemented at an accelerating rate. Each time an upgrade was implemented, the level of integration and organization of the System increased.

When the anarchistic System reached the critical connectivity threshold in 1939, it produced infinite levels of free energy (tensions). At that point the anarchistic System had reached its limits and collapsed as a consequence.

Increased order could subsequently only be achieved by simultaneously implementing dedicated non-anarchistic hierarchies in the core of the System, and a first global order at a global scale of the System. Through the implementation of dedicated hierarchies in Europe, the production of free energy (tensions) within these respective hierarchies was stopped.

The implementation of successive upgraded orders in the deterministic domain of the System, consistent with the second law of thermodynamics, was paralleled in the contingent domain with the implementation of successive international orders, with ever far reaching organizational arrangements. The first three international orders, so to say, 'paved the way', for the implementation of two dedicated non-anarchistic hierarchies in Europe (through the fourth systemic war, the Second World War, 1939-1945). The finite-time singularity was in fact instrumental in a long-term process (1495-1945) of social integration and expansion, and transformed a collection of hundreds of diverse and loosely connected units (1495), in a coherent highly integrated system, consisting of about 25 highly standardized states (1945).

285 The direction of development of the finite-time singularity dynamic: Locked in on increasing integration.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Upgraded orders, Collapse, Dual-phase transition.*

The outcome – the direction of development – of the finite-time singularity dynamic, accompanied by four accelerating cycles that unfolded during the period 1495–1945, toward increasing social integration and expansion, was already obvious at its inception. The System consistently and continuously pushed for further integration. The increasing incompatibility between increasing connectivity (interdependence) and security resulted in the production of higher levels of free energy (issues and tensions) at ever increasing rates. The increasing amounts of free energy were put to work during systemic wars, producing increasing levels of order. These orders 'embedded' the level of connectivity that the System had reached at that point of the System's development.

However, as I explained, increasing connectivity also produces increasing robustness. This effect explains why the number of non-systemic wars during successive relatively stable periods decreased deterministically.

Each (upgraded) order marks the next level of integration of the anarchistic System. In the contingent domain, these increasing levels of order 'at the same time' enabled the implementation of increasingly comprehensive organizational arrangements (rule sets, institutions, etc.) that made up successive international orders. 'Orders' and 'international orders' are counterparts in respectively the deterministic and contingent domain.

Three times the System could (through three systemic wars) design and implement upgraded orders within an anarchistic System, that (also) ensured compliance of the System with the demands of the second law of thermodynamics. However, at a certain point – when the System in 1939 reached the critical connectivity threshold (the singularity in finite time) – the System produced infinite amounts of free energy; at that point the incompatibility between connectivity (interdependence) of states in the anarchistic System and their security had become infinite: The anarchistic System had run out of options to design and implement a viable upgraded order that could address this condition. In response, through a dual-phase transition (the fourth systemic war, the Second World War, 1939-1945), the System simultaneously implemented two dedicated non-anarchistic hierarchies in the core of the System (Europe), and the first global order at a global scale of the System, to allow for a lower energy state of the System and ensure compliance with the second law of thermodynamics.

286 The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) increasingly resembled a war trap.

KEY WORDS *Singularity dynamic, Selection, Powerful-become-more-powerful effect, Survival, Acceleration, Production and deployment of destructive energy, War trap.*

The selection of the state as the fittest unit, and the powerful-become-more-powerful had a narrowing effect on the competition between states; increasingly selection and development of states 'focused' on their ability to produce and deploy ever increasing amounts of destructive energy, at an increasing pace. These properties determined their 'fitness' and survival changes in the anarchistic System.

These developments (in the contingent domain of the anarchistic System), interacted with the (simultaneous) acceleration of the cycles that accompanied the finite-time singularity dynamic. Because of the accelerating amounts of free energy, the anarchistic System produced, the frequency as well as the amplitudes of successive cycles accelerated as well (amplitudes concern the severity of systemic wars, and are indicative for the destructive energy that is deployed).

The undisturbed unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles, required that states in the System continuously improved their ability to produce and deploy increasing amounts of destructive energy.

As a consequence of these (coevolving) developments, the System increasingly resembled a 'war trap'; a self-imposed war trap to be more precise.

17 CHANGE

287 It is possible to distinguish seven types of changes in the deterministic domain of the System.

KEY WORDS *Deterministic domain, Change, System, Dedicated non-anarchistic hierarchies, Upgraded orders, Low-connectivity regime, High-connectivity regime, Chaotic war dynamics, Non-chaotic ward dynamics, Non-systemic wars, Merging, Core, Non-core.*

This study shows that seven types of changes can be distinguished in the deterministic domain of the anarchistic System; these levels of change can be derived from the workings of the finite-time singularity dynamic accompanied by accelerating cycles (1495-1945) and the insights it provides. In all seven cases, the changes were not caused by exogenous factors but were the outcome of the intrinsic internal and coevolutionary dynamics of the System itself.

1 ***A change from a collection of unconnected units to a system***
This change was accomplished when a collection of unconnected units reached the percolation threshold around the year 1495. These units became connected in an integrated system. The accompanying mechanism of change was connectivity growth through population growth. This change affected the System.

2 ***A change in the fundamental structure of the System: the merging of nodes in dedicated non-anarchistic hierarchies***
This change was accomplished when the anarchistic System reached the critical connectivity threshold in 1939, collapsed, and experienced a phase transition towards the implementation of dedicated non-anarchistic hierarchies in its core (Europe). Within these dedicated hierarchies, anarchy and the production of free energy were neutralized, ensuring limits to the production of free energy (tensions) in the System (consistent with the second law of thermodynamics) and the survival of populations in these hierarchies. The accompanying mechanism of change was a phase transition. A phase transition required criticality, and manifested itself in the contingent domain through the fourth systemic war (the Second World War, 1939-1945). This change affected the System.

3 ***A change in the order of successive relatively stable periods***
During the unfolding of the singularity dynamic, upgraded orders were introduced three times through systemic wars. Upgraded orders provided increased structural stability and (renewed) opportunities for states to fulfill their basic requirements. The accompanying mechanisms of change were criticality in the deterministic domain and systemic war in the contingent domain. This change also affected non-systemic war dynamics between states during successive relatively stable periods (international orders).

4 ***Change from a low- to a high-connectivity regime during relatively stable periods***
At the tipping point during the life cycle of relatively stable periods (dividing low- and high connectivity regimes), states in the System reached a degree of connectivity that resulted in increased local stability and limited the sizes of non-systemic wars the System could produce. High-connectivity regimes deprived the System of the option to release tensions through non-systemic wars and instead resulted in the build-up of free energy release deficits that crystalized in vulnerable issue clusters with fractal structures. The vulnerable issue clusters eventually percolated the System, caused the System to become critical and produce a systemic war, to restore a viable level of order. The accompanying mechanism of change was increasing connectivity. The change affected (1) the sizes of non-systemic wars the System could produce during relatively stable periods, (2) the free energy that could be stored in the System (the 'size' of the free energy release deficit), (3) the formation of percolating vulnerable clusters, (4) the System's criticality, and (5) the System's ability to implement upgraded orders through systemic wars.

5 ***Change from a high-connectivity regime to criticality and systemic war***
During the final stage of high-connectivity regimes of relatively stable periods, vulnerable issue clusters eventually percolated the System and caused it to become critical. A critical condition means, that the correlation length of the System had become 'one'; a condition that allowed for system-wide communication, coordination and planning. At that point, the System's susceptibility had become infinite, meaning that even a small incident could trigger a systemic response (war). The 'outbreak' of the third systemic war (the First World War, 1914-1918) illustrates these typical system properties and dynamics. When the percolating vulnerable issue cluster was triggered – activated – the condition of the System then abruptly changed from what could be defined as a stable condition to systemic war. The accompanying mechanism of change was increasing connectivity and a percolating vulnerable cluster that triggered a system-wide response.

The change affected the level of war in the System from the absence of non-systemic wars, which were effectively suppressed by the local stability of states as a consequence of the high connectivity of the System, to systemic war. This change allowed the System to implement upgraded orders through systemic wars.

6 ***A change from chaotic to periodic non-systemic war dynamics, and vice versa***
During the unfolding of the (first) finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the anarchistic System experienced two bifurcations: a bifurcation from a chaotic to a periodic regime (1657), and vice versa (1763). During the exceptional period (1657-1763), non-systemic war dynamics were more regular and more extreme, contrary to intrinsically unpredictable and more restrained war dynamics

during chaotic conditions. The accompanying mechanism of change was a change in the number of degrees of freedom (n) in the System; n > 2 implies chaotic dynamics, while n = 2 implies periodic conditions. The intensity of rivalries between states in the System determined how many states – variables, degrees of freedom – were taken into account regarding war decisions.

The change affected the nature of non-systemic war dynamics of the System. Extreme and more regular wars occurred during periodic dynamics (n = 2) versus more restrained and intrinsically unpredictable wars during chaotic dynamics (n > 2). The periodic war dynamics delayed the buildup of a free energy release deficit, and the crystallization of this energy (tensions) in vulnerable issue clusters with fractal structures. As a consequence, the System was delayed in reaching criticality, produce a next systemic war, and implement an upgraded order. Extreme non-systemic wars during the exceptional period (1657-1763) negatively affected the development and unfolding – and the efficiency – of the finite-time singularity dynamic.

7 ***A change of the relationship of the System (its core) with its environment (non-core); merging of core and non-core***

In 1939 the core of the System (Europe) reached the critical connectivity threshold, and as a consequence produced infinite amounts of free energy (tensions); in response the core of the System became critical. In December 1941, as a consequence of Japan's attack on the United States (Pearl Harbor, 7 December 1941), and Germany's declaration of war on the United States (11 December 1941), vulnerable issue and war clusters in the non-core linked with the critical core. At that point the System became critical at a global scale. December 1941 marks the globalization of the System, and the merging of the core and non-core of the (now global) System. To ensure consistency with the second law of thermodynamics, the System produced a dual-phase transition (through the fourth systemic war, the Second World War, 1939-1945), that resulted in the simultaneous implementation of two dedicated non-anarchistic hierarchies in the core of the System, and the first global order at a global scale of the System; the European order had now become an integral part of a global order.

288 The seven types of changes in the deterministic domain have their counterpart equivalents in the contingent domain of the System.

KEY WORDS *Deterministic domain, Contingent domain, Counterparts, Anarchy, Non-anarchy, Low-connectivity regime, High-connectivity regime, Criticality, Chaotic war dynamics, Non-chaotic war dynamics.*

In the table below I show the seven deterministic changes and their respective contingent counterparts.

	Deterministic changes and their contingent counterparts	
	Change in the deterministic domain	Contingent counterpart/equivalent
1	A change from a collection of unconnected units to a system.	Units (states) became interconnected; different parts of the System started interacting and influencing each other; information and tensions could be transmitted through the System.
2	A change in the fundamental structure of the System: the merging of nodes in dedicated non-anarchistic hierarchies.	A change from anarchy to non-anarchy in the respective dedicated hierarchies.
3	A change in the order of successive relatively stable periods	Implementation of increasingly comprehensive organizational rule sets that underpinned successive international orders.
4	Change from a low- to a high-connectivity regime during relatively stable periods.	During low-connectivity regimes, an average increase in the size of non-systemic wars; during high-connectivity regimes, an average decrease in the size of non-systemic wars.
5	A change from a high-connectivity regime to criticality and systemic war.	An abrupt change from the relative absence of non-systemic wars to systemic war.
6	A change from chaotic to periodic non-systemic war dynamics, and vice versa.	A change from relatively constrained and intrinsically unpredictable non-systemic wars to more predictable non-systemic wars extreme in size and severity.
7	A change of the relationship of the System (its core) with its environment (non-core); merging of core and non-core	A change from a core and non-core configuration of the System, to an overarching global order, that included the (upgraded) European order.

Table 101 *This table shows deterministic changes and their equivalent counterparts in the contingent domain.*

289 Changes in the System are related to more gradual changes in a number of conditions and properties of the System.

KEY WORDS *Condition, Property, System, Connectivity, Intrinsic incompatibility, Security, Anarchy, Pace of life, Structural stability, Robustness, Fragility, Path dependence, Lock-in.*

In the previous statement I discussed seven types of changes in the deterministic domain of the System. These relatively abrupt changes are closely related to a gradual change in a number of related conditions and properties of the System. These conditions and properties include:

1 ***Connectivity***
Connectivity is the control parameter of the System, and has an impact on all conditions and properties of the System. Population growth and rivalry between

states determine the System's connectivity, including the network of vulnerable issue clusters. The connectivity of the System increased at an accelerating rate during the unfolding of the finite-time singularity dynamic (1495-1945).

2 ***The intrinsic incompatibility between connectivity and security in the anarchistic System. T***
he level of incompatibility between connectivity and security in the anarchistic System is a function of the System's connectivity; connectivity is the driver of the System. The level of incompatibility of the anarchistic System determined the free energy the System produced as tensions in the contingent domain. The accelerating growth of the connectivity of the System during the unfolding of the finite-time singularity dynamic (1495-1945) resulted in the accelerating growth of free energy – tensions – in the System. Because of the unsustainability of the accelerating growth rate of free energy, the System reached a critical connectivity threshold (a singularity in finite time) in 1939; at that point the System produced infinite levels of free energy and as a consequence collapsed.

3 ***The pace of life in the System and the speed of spreading phenomena, including tensions***
Connectivity also determined the pace of life in the System, including the speed of spreading phenomena. The pace of life in the System, synonymous with the connectivity of the System, determined how fast tensions could be produced and spread, and how fast the finite-time singularity unfolded and accelerated.

4 ***Local stability of the System***
Local stability of the System also is a function of its connectivity. Besides a faster pace of life and a higher level of incompatibility of the anarchistic System, higher connectivity implied increased local stability. Local stability of the anarchistic System contributed to the ability of the System to store free energy, and determined how much free energy had to be put to use as destructive energy to enable the implementation of upgraded orders.

5 ***Robustness of the System***
The robustness of the System is closely related to the System's structural stability, and is defined as the susceptibility of the System to perturbations. The number of non-systemic wars the System produced during the relatively stable period of a particular order is a measure of its robustness. Robustness also is a function of the System's connectivity, and increased linearly during the unfolding of the singularity dynamic (1495-1945).

6 ***Fragility of the System***
Fragility of the System is determined by the ability of the System to maintain itself within a certain order. The life span of international orders is a mea-

sure of fragility. Robustness and fragility are two sides of the same coin: the robustness of the System determined its fragility. Fragility (also) increased linearly during the unfolding of the singularity dynamic (1495-1945), and is also a function of the connectivity of the System.

7 ***Degree of path dependence and lock-in***
The degree of path dependence and lock-in shaped the direction of development of the anarchistic System, and determined to what degree the System allowed for diversions from its path of development. During the unfolding of the singularity dynamic, both the deterministic and the contingent domains became increasingly dominated by systemic wars that were produced at an accelerating rate and with accelerating intensities/severities. This dynamic produced a number of path-dependent dynamics and lock-ins. States were forced to maximize their capabilities to fight wars, and organizational arrangements that underpinned successive international orders became progressively more comprehensive in their efforts to restrain/contain free energy levels.

It is important to note that these changes in the conditions and properties of the System (1495-1945) were not caused by exogenous factors; all these changes were the outcome of the intrinsic internal and coevolutionary dynamics of the anarchistic System.

290 The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), a product of the second law of thermodynamics, forced changes on the contingent domain of the System.

KEY WORDS *Singularity dynamic, second law of thermodynamics, Deterministic domain, Contingent domain, Contingent latitude, Change.*

The intrinsic incompatibility between connectivity and security in the anarchistic System resulted in the production of increasing levels of free energy in the form of tensions in the contingent domain. Consistent with the demands of the second law of thermodynamics, the free energy (tensions) was periodically put to work through systemic wars in the contingent domain of the System, to implement upgraded orders that allowed for lower free energy states in the System's successive international orders. This process enabled the collective fulfillment of basic requirements by uneven states and their populations in the anarchistic System, and was a precondition for their survival.

The second law of thermodynamics determined the dynamics and properties of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) that it produced. The finite-time singularity dynamic set the stage for the dynamics that developed in the contingent domain. The changes in the contingent domain were forced on it by the singularity dynamic that was, itself, a product of the second law of thermodynamics.

The deterministic domain (deterministic laws) also determined how much latitude ('contingent latitude') was allowed for dynamics in the contingent domain of the System

291 The models and theories of change that social scientists and historians developed show fundamental shortcomings and are based on wrong and incomplete assumptions.

KEY WORDS *Historical research, Methodology, Deterministic domain, Shortcomings, Change, Interaction change, Rank order change, Change in constitutive units, second law of thermodynamics, Dedicated non-anarchistic hierarchies, Exogenous change, Intrinsic dynamics.*

Historians and social scientists have extensively studied events, developments and change in social systems, including in the international system. However, their interpretations of events and the 'causalities' they identified (constructed), did not take the (decisive) impacts of the 'underlying' deterministic domain into consideration. These historians and social scientists were not aware of the existence of such a deterministic domain, let alone of the application of deterministic laws to the System's dynamics and developments. As a consequence, their research and interpretations are incomplete and often misguided.

In this statement (but see also part V) I discuss a number of evident shortcomings in interpretations and explanations.

Spruyt, for example, makes the following observations regarding change. He distinguishes three levels of change in international relations: (1) interaction change, (2) rank order change, and (3) change in the constitutive units (66).

1 *Interaction change*

Spruyt explains that interaction change, the change of diplomatic practices, is the most susceptible to individual decision-making. Such practices are influenced by the presence of particular decision makers and by specific strategic choices.

According to this study, interaction change, as far as it is as relevant as Spruyt suggests, does not constitute a change mechanism. Interactions of decision makers are determined and shaped by deterministic laws and interacting self-fulfilling prophecies ensure that the deterministic and contingent domains are synchronized.

2 *Rank order change*

Spruyt's second level of change concerns 'shifts in the distribution of capabilities'. He observes, "This type of change occurs less frequently. Changes in relative powers, occur, by some accounts, every century or century and a half. Such changes might correspond with periodic cycles in the economy."

I consider 'shifts in the distribution of capabilities' (Spruyt...) and Great

Power status dynamics (more or less) synonym (closely related) phenomena. This study shows that significant changes in the Great Power status hierarchy eventually came to a halt when the critical connectivity threshold was reached in 1939, and the anarchistic System became highly stable as a consequence.

Furthermore, contrary to what Spruyt argues, 'centuries or centuries and a half' are not sensible 'units' of analysis for the dynamics and developments in the System; the dynamics and development of the System are determined and shaped by four accelerating cycles that accompany the finite-time singularity; a singularity in finite time is unavoidable because the accelerating growth rate of free energy (tensions) in the System cannot be sustained, and caused the anarchistic System's collapse in 1939.

This study also shows that there is no correlation between economic cycles (Kondratieff cycles), and the four accelerating cycles that made up the finite-time singularity dynamic (1495-1945) (39).

3 *Change in constitutive units*

The third and final level of change that Spruyt introduces concerns unit change. Unit change, for example, concerns the change from city-states to empires, or from empires to feudal organizations, and occurs least often. According to Spruyt, "When a particular type of unit comes to dominate the international system, it transforms the deep structure of the system."

This also is a misrepresentation. Units (states) and international orders coevolved, and were (and still are) inseparably linked structures. 'Unit-change' is a long-term and continuous process that started the moment the first humans decided to form collective structures, and is still unfolding.

Spruyt further argues, "My discussion (*IP: regarding the process of unit change*) ends at about the time the Peace of Westphalia (1648) which formally acknowledged a system of sovereign states. This is not to say that the process of eliminating alternatives to states had been completed by then. But it did indicate that the variety in the types of units that existed in the Late Middle Ages was gradually being reduced, until later only a system of states remained."

Although at that point in time (1648) the state-structure was adopted as the formal and only legitimate unit-structure of the System, states continued evolving, together with successive international orders. States constantly improved their ability to mass-mobilize and produce and deploy increasing amounts of destructive energy, changed their forms and sizes, and adopted increasingly comprehensive collective organizational arrangements in international orders.

This study shows that the moment the anarchistic System became obsolete and collapsed in 1939, its development (the development of the *anarchistic* System) was 'complete'; further improvements and modifications to state structures and anarchistic international orders were not possible anymore. The anarchistic System – so to say – had at that point exhausted all its options.

As demanded by the second law of thermodynamics, clusters of states in the core of the System (Europe) were forced to implement dedicated non-anarchistic hierarchies in order to lower the energy state of the core of the System.

In fact, state structures that were products and integral parts of the preceding anarchistic System (and singularity dynamic it produced) became obsolete in certain regions in the core of the System, because of their high connectivity; in response the System (consistent with the second law of thermodynamics) implemented two dedicated non-anarchistic hierarchies in these highly connected regions: The fate of the anarchistic System and states was, and is, inseparably linked.

Spruyt further argues that: "a change in the constitutive units of the system is only likely to occur after a broad exogenous change, or an environmental shock." This study shows that the changes the System experienced were not the outcome of broad exogenous changes or environmental shocks, as Spruyt suggests, but in all cases were the outcome of intrinsic/endogenous dynamics of the System.

292 In the contingent domain of the System, besides the incentives of dominant states to maintain 'their' privileged international orders a number of 'factors' contribute to the System's metastability.

KEY WORDS *Metastability, Inertia, Privileges of dominant states.*

Janssen et al. (61) argue that a number of factors contribute to the failure of ancient societies to adapt to change. These factors also apply to the (contingent domain of the) anarchistic System, and include: (1) the tendency of societies to stay committed to decisions, because of the (social) costs (reaching consensus) invested in them, (2) the priority that is given to maintaining social unanimity (coherence), (3) different risk perceptions, (4) short-term thinking, (5) denial, (6) specific interests, (6) dysfunctional decision-making processes, (7) unawareness (a lack of understanding of the workings of the system these actors are an integral part of), (8) the perception that some changes are still reversible in a later stage, and (9) the 'structure' of decision making processes. These and other factors contribute to the 'inertia' of societies: their unwillingness, unawareness and inability to react (timely) to (required) changes and risks.

293 Connectivity growth determined – and still determines – the rate of change (development) of the System.

KEY WORDS *Change, Rate of change, System, Singularity dynamic, Development, Connectivity.*

Change – implementation of upgraded orders in the anarchistic System – was (and still is) accomplished through systemic wars. Systemic wars are integral components of the first finite-time singularity dynamic that unfolded in the System during the 1495-1945 period. The finite-time singularity dynamic was accompanied by four accelerating cycles. The rate of change – development – of the System is determined by its connectivity growth: The rate of change of the anarchistic System was accelerating during the 1495-1945 period. Population growth is the main driver of connectivity; population size determines the System's pace of life.

Because the population of the System was continuously growing during the 1495-1945 period, there was no permanent equilibrium in the System. This still now still is the case, during the unfolding of the second finite-time singularity dynamic (1945-…).

The System was – and still is – a disequilibrium system, and must continuously find a (new) balance between order and disorder to maintain its performance; the performance of the System concerns its ability fulfill the basic requirements of growing populations (that are organized in states) in the anarchistic System.

The changes (integration of the core, and expansion from the core to non-core) and the rate of change the first singularity dynamic accomplished, ensured that the total population of the core of the System (Europe) could grow from 83 million in 1495 to 544 million in 1945, and be sustained.

18 SOCIAL INTEGRATION AND EXPANSION (SIE)

294 The period 1495-1939 is a distinct phase in the long-term process of social integration and expansion.

KEY WORDS *SIE, Distinct phase, Singularity dynamic, Path dependence, Cycles, second law of thermodynamics, Intrinsic incompatibility, Population growth, Connectivity, Control parameter, Integration, Expansion.*

In 1495 the long-term SIE process started a distinct new phase when a collection of a large number of loosely connected and divers units in Europe became sufficiently connected to develop system-behavior: the multitude of interactions between these units produced a very regular self-organized macro-dynamic, that started an increasingly path dependent and locked-in dynamic that ultimately resulted in a dual-phase transition (the fourth systemic war, the Second World war, 1939-1945): simultaneous implementation of two dedicated non-anarchistic hierarchies in Europe (what had become the core of the increasingly expanding System), and the first global international order at a global scale of the System.

The self-organized highly path dependent dynamic the System produced during the period constitutes a finite-time singularity accompanied by four accelerating cycles. Each cycle consists of a relatively stable period followed by a systemic war. During each relatively stable period the anarchistic System produced consistent with the demands of the second law of thermodynamics accelerating amounts of free energy, that were put to work by systemic wars to implement upgraded orders that allowed for lower energy states of the System. The energy (tensions) the System produced were a product of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic Systems; the anarchistic System produced free energy (tensions) at an accelerated rate. Connectivity – the control parameter of the anarchistic System – was itself continuously 'powered' by population growth in the System. When the System reached the critical connectivity threshold – the singularity in finite time related to the accelerating growth rate of the connectivity of the System – the anarchistic System collapsed and produced above mentioned phase transition. The ultimate collapse of the System and resulting phase transition was preceded by three systemic wars – upgrades of orders of the anarchistic System – that at that stage could be still designed and implemented in the anarchistic System. During this distinct phase of social integration and expansion the large number of loosely connected and divers units in (Europe) transformed through the finite-time singularity dynamic accompanied by four accelerating cycles, in a highly integrated system of a significant smaller number of highly standardized states. This transformation process – concerning the units of the System during the period 1495-1939 – went hand-in-hand with the simultaneous development of successive international orders, that reflected the increasing interdependence and integration of units (states) in the System. The simultaneous transformation of units in the anarchistic System, and international orders these units implemented through a series systemic wars, constitutes a co-evolutionary process.

295 The singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period was instrumental is producing a next level of SIE in the System.

KEY WORDS *Singularity dynamic, Integration, Expansion, Core, Non-core, Dual-phase transition, second law of thermodynamics, SIE.*

As a consequence of the intrinsic incompatibility between increasing connectivity and security in the anarchistic System, connectivity growth resulted in the production of accelerated amounts of free energy (tensions) in the System. In response to the increasing free energy (tensions) in the System, and in compliance with the second law of thermodynamics, the System periodically implemented upgraded orders through systemic wars, to allow for a lower energy state of the System.

However, these orders only provided temporary respite. The accelerating growth of free energy (tensions), also led to an acceleration in the frequency of successive cycles. The moment the System reached in 1939 the critical connectivity threshold, the anarchistic System produced infinite amounts of free energy (tensions) and collapsed as a consequence; its collapse led to a dual-phase transition.

The three systemic wars that preceded the phase transition produced increasingly higher levels of order; the fourth systemic war (the Second World War, 1939-1945) constituted the phase transition.

Through the dual-phase transition, the System implemented dedicated hierarchies in Europe, the core of the System: A Western hierarchy controlled by the United States and an Eastern hierarchy controlled by the Soviet Union. Within respective hierarchies, anarchy and the production of free energy were neutralized, ensuring (temporary) compliance of the System with the second law of thermodynamics.

However, at the same time as the anarchistic System produced a finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) that was instrumental in a process of integration in the core of the System (Europe), the singularity dynamic also initiated a process of expansion of Europe to the non-core. The expansion process also was a phased process that was synchronized with the process of integration in the core of the System.

Both processes – integration of the core and expansion to the non-core – coevolved and reinforced and shaped one another; both dynamics were the result of the accelerating amounts of free energy (tensions) the System produced, and of the application of the second law of thermodynamics. At the same time as the core experienced a phase transition, the core (Europe) and non-core of the System also merged, and a first global order was implemented at a global scale of the System. The implementation of the first global order constitutes the second component of the dual-phase transition.

The implementation of dedicated hierarchies in the core of the System (Europe) and the implementation of a global international order were inseparably linked; one could not be implemented and effective without the other.

The outcome of this process can be considered a next phase in the long-term process of social integration and expansion (SIE); a process that started millennia ago, and still is unfolding.

296 Implementation of dedicated hierarchies in the core of the System (Europe, 1939-1945) was the final step in a gradual process of 'horizontal' and 'vertical integration', that was enabled and shaped by a finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period in the anarchistic System.

KEY WORDS *Integration, Direction of integration, Horizontal, Vertical, Singularity dynamic, Dedicated non-anarchistic hierarchies.*

It is possible to distinguish between two directions of integration in the System: 'horizontally' - between states in the System - and 'vertically' between states and successive international orders that defined their relationships, and how states were supposed to (inter)act.

Horizontal integration typically increased during relatively stable periods following systemic wars; during relatively stable periods, states became more connected and more interdependent as a consequence of their efforts to fulfill their basic requirements as effectively and efficiently as possible. Vertical integration was accomplished through increasingly comprehensive organizational arrangements that were implemented during successive systemic wars. These upgraded orders not only ensured that the power and influence positions of dominant states was embedded in these upgraded order, but also that the connectivity between states – their continuously increasing interdependence – was taken into consideration.

This step-by-step process of horizontal and vertical integration was determined and shaped by the finite-time singularity dynamic accompanied by four accelerating cycles that unfolded in the anarchistic System during the 1495-1945 period; this step-by-step process paved the way for the implementation of dedicated hierarchies in the core of the System during the fourth systemic war (the Second World War, 1939-1945).

297 To avoid self-destruction, SIE was the necessary direction of development of populations and states in the System.

KEY WORDS *SIE, Upgraded orders, second law of thermodynamics, Integration, Dual-phase transition.*

The finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period, optimized the System's performance and evolvability. When the core of the System in 1939 reached the critical connectivity threshold and produced infinite levels of free energy (tensions) as a consequence, all organizational possibilities to implement a viable upgraded order in an anarchistic System were exhausted, and the intrinsic incompatibility between (increasing) connectivity and security could no longer be bridged.

In reaction to this condition, consistent with the second law of thermodynamics, the System produced a dual-phase transition (the fourth systemic war, the Second World War, 1939-1945) that resulted in the implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a first global international order at a global scale of the System.

The implementation of dedicated non-anarchistic hierarchies in the core of the System and the simultaneous implementation of a global order, in fact constitutes the implementation of a next level of social integration and expansion (SIE) in the contingent domain of the System. This was the only viable 'choice' for the System; it ensured compliance with the second law of thermodynamics, and prevented collective self-destruction.

298 The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) and the next level of SIE in which it resulted, are self-organized and unavoidable results of the urge of growing populations to survive, and of deterministic laws, including the second law of thermodynamics, that apply to the interactions states and their growing populations undertake to fulfill their basic requirements.

KEY WORDS *SIE, Basic requirements, Self-organization, urge to survive, Deterministic laws, second law of thermodynamics, Lower energy state.*

During the 1495-1945 period, interactions between states (populations) to collectively fulfill their basic requirements intensified and accelerated as a consequence of growing populations and increasing connectivity of the System.

Because of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems, connectivity growth resulted in the accelerating production of free energy (in the form of tensions in the contingent domain), to which the second law of thermodynamics applied.

The second law of thermodynamics demanded that the free energy (tensions) was periodically put to work, to implement upgraded orders that allowed for lower energy states in the anarchistic System. Lower energy states (upgraded orders) provided the necessary structural stability to the anarchistic System, to ensure the fulfilment of basic requirements of growing populations.

The upgraded orders that were implemented in the deterministic domain allowed for increasingly comprehensive organizational arrangements (international orders) in the contingent domain of the System; these dynamics also enabled ever-closer cooperation and integration between states.

Ultimately, the anarchistic System in 1939 reached the critical connectivity threshold, produced infinite amounts of free energy (tensions) and collapsed as a consequence. At that point the anarchistic System could no longer reconcile the intrinsic incompatibility between increasing connectivity and security, by implementing an upgraded order in an anarchistic context. In response, the second law of thermodynamics produced a dual-phase transition (the fourth systemic war, the Second World War, 1939-1945). Through the dual-phase transition, two dedicated non-anarchistic hierarchies were implemented in the core of the System (Europe) and a first global order at a global scale of the System. These 'upgrades' allowed for a lower energy state of the (now global) anarchistic System, necessary to further accommodate the basic requirements of (growing) populations.

299 Through expansion and acquisition of political control over non-core territories, European states improved their ability to fulfill their basic requirements and enhanced their power and influence over rival states inside and outside the core of the System.

KEY WORDS *Singularity dynamic, Core, Expansion.*

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), European states expanded their power and influence by acquiring and exploiting resources and markets outside of Europe (the core of the System). In order to optimize the exploitation of these resources, European states established increasing levels of political control in these areas (colonies). The additional power and influence that could be generated through expansion contributed to their power and influence and to rivalries in Europe. The development and unfolding of the finite-time singularity dynamic (1495-1945) became increasingly dependent on resources acquired outside of Europe.

300 Shared realities are a prerequisite for social integration; war interactions contribute to the creation of shared realities.

KEY WORDS *Reality, Reality creation, Reality sharing, War, Interacting self-fulfilling prophecies, Survival, Population growth, Integration.*

States and their populations create their 'own' realities through interacting self-fulfilling prophecies. States and their populations base their (inter) actions on the realities they create and (as a consequence) perceive; realties are also used as justifications.

The 'realities' of states and populations in the System are subjective in nature and continuously (re)created through interactions; an objective reality, independent of these interactions does not exist.

Realities – including the (international) orders states and their populations share – are about interactive relationships. War is a form of interaction and contributes to the creation of shared realities. The finite-time singularity dynamic, accompanied by four accelerating cycles (1495-1945) consisted of a series of wars, that followed a deterministic logic. During systemic wars, states and their populations create (design) collective realities, that are then embedded in upgraded orders; upgraded orders are 'newly' shared realties.

Through its path dependent nature, coevolution of states and successive international orders, and the powerful-become-more-powerful effect, the finite-time singularity created a series of increasingly shared and increasingly converging realities. These converging realities paved the way – prepared states in the core of the System – for the eventual implementation and acceptance of two dedicated non-anarchistic hierarchies in the core of the System (Europe). These two dedicated non-anarchistic hierarchies were implemented through the fourth systemic war (the Second World War, 1939-1945).

The fact that states and their populations became increasingly dependent on each other for their (mutual) survival, also forced states and their populations to share and synchronize their realities. Population growth, creating shared realities, integration and survival are inseparably linked in anarchistic systems.

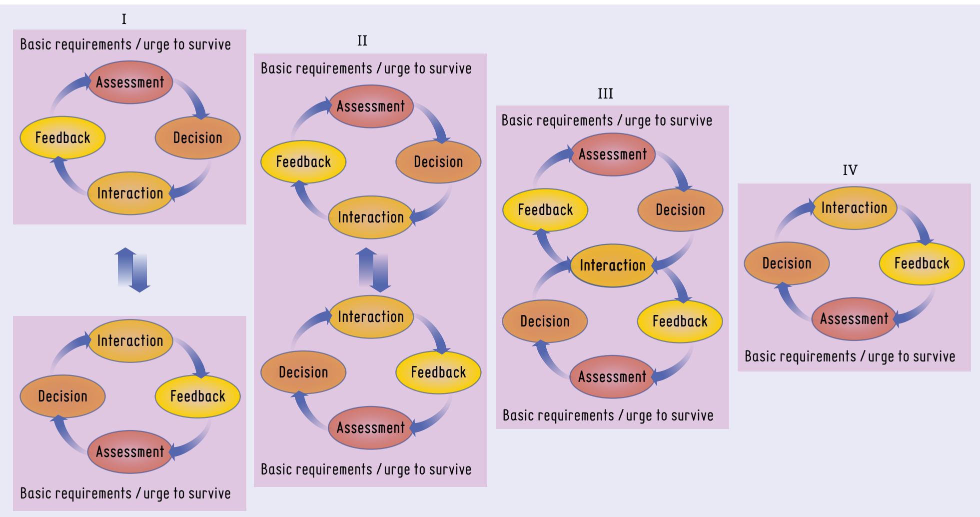


Figure 120 *In above figure states (social systems) are depicted as dynamical systems – 'loops' – that continuously (must) assess their condition and environment, decide on interactions, take action, and evaluate the effects of their interactions (feedback). The urge to survive and the need to fulfill basic requirements provide a reference and constancy to these pro-*

cesses. Through interactions states create their 'own' realities. Increasing interdependency make – 'force' – states to 'integrate' their realities, their (perceptions of their) basic requirements and the processes of assessment, decision, action and feedback. I distinguish four phases: (I) interdependent interactions, (II) interactions based on 'shared' perceptions but still independent interactions, (III) shared interactions (implying coordination of assessment, decisions, and feedback), and (IV) full integration (the next level of SIE).
Europe is (mainly) in phase III, but struggling to make the transition to phase IV.

301 Interactions create shared realities, and are a prerequisite for integration.

KEY WORDS *Interactions, Reality, War, Order, Integration.*

The (re)creation and maintenance of order require shared realities; (re) creation and maintenance of shared realities require constant interactions. Order cannot be maintained without interactions and the input of energy. Order in anarchistic systems cannot be created and maintained without war.

A prerequisite for implementing non-anarchistic orders is an (implicit) awareness – an (implicit) shared reality – that collective survival requires integration and cooperation.

The first three upgraded orders the anarchistic System produced through the first finite-time singularity accompanied by four accelerating cycles (1495-1945), included increasingly comprehensive arrangements that underpinned successive orders. Each order can be interpreted as a next level in mutual awareness and shared reality.

302 Expansion of European states (outside Europe), led to a 'core' and a 'non-core' in an increasingly globalizing System.

KEY WORDS *Core, Non-core, Expansion, Integration, 1941, second law of thermodynamics, Dual-phase transition.*

Through a process of expansion of European states, Europe and territories outside Europe developed, respectively, as the core and non-core of an increasingly global system. Expansion of European states led to the introduction of European rivalries outside of Europe in the non-core of the System.

Increasingly, the political control structures European states implemented in non-core territories, resembled states, that had to ensure that the non-core territories met the requirements of respective European states that controlled them.

Over time, the non-core developed from a collection of diverse and loosely coupled units that were tightly coupled only with their respective European colonizers, into an integrated global system. Over time, not only did the non-core become internally more connected and started developing increasingly autonomous dynamics, but non-core states also increasingly connected to core states other than their colonizers. By doing so, they diversified and intensified their connectivity.

In 1941, the (now) globally connected System experienced its first systemic war at a global scale, that led to the implementation of the first global order, which – together with the two dedicated non-anarchistic hierarchies that were implemented in the core of the System – allowed for a lower global energy state of the now global anarchistic System, consistent with the demands of the second law of thermodynamics.

The simultaneous implementation of upgraded orders in the core and non-core of the (now global) System through a dual-phase transition (the fourth systemic war, the Second World War, 1939-1945), in fact was the merging of the core and non-core of the System, and marks its actual globalization.

303 During the unfolding of the finite-time singularity dynamic (1495-1945), the anarchistic System developed from a collection of diverse and loosely connected units into a System of highly standardized and connected states that continuously improved their ability to produce, mobilize, and deploy destructive power.

KEY WORDS *Singularity dynamic, Standardization, States, second law of thermodynamics, Robust, Fragile, Destructive energy.*

Tilly observes that around 1490, alternative opportunities regarding the direction of development of what would become the anarchistic System were foreclosed and Europeans "set off decisively toward the creation of a system consisting almost entirely of relatively autonomous national states" (70). But, Tilly explains, "states, on the other hand, diminished in number and increased in area: over the next four centuries, many war settlements and a few deliberate federations drastically reduced the number of European states. During the nineteenth century, the number stabilized."

How the number of unit states decreased over time depends, as Tilly puts it, "on contestable decisions bearing on the very nature of the eras of states." Tilly observes that around 1490 "no plausible set of definitions yields fewer than 80 distinct units or more than 500."

Despite the difficulty of accurately defining units, it was obvious that "Europe was beginning to consolidate into territorially distinct states organized around permanent military establishments, and military superiority was starting to give the larger states better changes of survival... Over the next four centuries, many war settlements and a few deliberate federations drastically reduced the number of European states. During the nineteenth century, the number stabilized." Size matters in an anarchistic system.

"Major consolidations occurred with the formation of the German Empire and the Kingdom of Italy. By the start of 1890, the roster of states had declined to about 30, of which nine were members of the German Empire. At the end of 1918, the count stood at around 25 separate states. Although boundaries changed significantly with the settlements of World Wars I and II, the number and size of European states did not change dramatically during the twentieth century."

This study shows that, in fact, the dynamics in the 'type', number, and size of units (states) that Tilly describes were determined and shaped by the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945). Growing populations of states, in combination with laws that applied to their interactions, led to the accelerated growth of free energy (tensions) in the anarchistic System. These accelerating levels of free energy had to be put to work by the System at accelerating frequencies to meet the demands of the second law of thermodynamics.

Because the ability of states to collectively fulfill their basic requirements was largely determined by the outcome of systemic wars, states continuously improved their ability to produce, mobilize, and deploy destructive energy; by doing so they ensured the development and unfolding of the finite-time singularity dynamic.

The demands of the self-organized singularity dynamic and the urge of populations and states for survival, contributed to the consolidation of units, their resizing, and increasing war fighting capabilities; these properties are closely related.

The development of the anarchistic System, from a collection of divers and loosely connected units (1495), to a highly integrated system of about 25 highly standardized states (1939), Tilly describes from a contingent perspective, but was in fact a 'product' of the second law of thermodynamics, achieved through the highly deterministic finite-time singularity that unfolded in the anarchistic System during the period 1495-1939.

As I explained, during the unfolding of the finite-time singularity dynamic, the anarchistic System became increasingly robust, and fragile; while successive relatively stable periods (international orders), became increasingly structurally stable. The increasing structural stability of successive international periods, is closely related to the increasing permanence of the Great Power status hierarchy, and the crystallization of states (the territories they controlled) in fractal structures. These fractal structures contributed (as far as possible), to a minimization of tension-production during relatively stable periods, and to the optimized deployment of destructive energy during systemic wars.

304 During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the anarchistic System continuously optimized its performance and evolvability to ensure the collective fulfillment of basic requirements of growing populations of states.

KEY WORDS *Singularity dynamic, Basic requirements, Performance, Evolvability, Permanence, Great Power status dynamics, Fractal structures, Size-distribution of states.*

During the unfolding of the finite-time singularity dynamic the anarchistic System continuously optimized its performance and evolvability, 'pushed' by the need to fulfill the basic requirements of growing populations of states and by the laws that applied to their interactions. Performance of the anarchistic System refers to its ability to fulfill the basic requirements of uneven states in the anarchistic System, and concerns relatively stable periods (international orders), while evolvability refers to the System's ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars.

The finite-time singularity dynamic accompanied by four accelerating cycles, a 'product' of the second law of thermodynamics, ensured that the performance and evolvability of the anarchistic System were balanced.

During the process of consolidation of unit (states), the structural stability of successive relatively stable periods (international orders) continuously increased. During the unfolding of the finite-time singularity dynamic, two further properties of the System were also indicative of its continuous optimization, and increase in structural stability: (1) *the increasing permanence of the Great Power status hierarchy*: Great Power status dynamics in the System decreased linearly and came to a halt during the fourth international order (1918-1939), implying that the Great Power status hierarchy had achieved permanence, and (2) *the crystallization of states in fractal structures* that ensured that the production of free energy (tensions) during relatively stable periods was minimized, and the distribution of destructive energy by states during systemic wars was optimized.

305 The moment the System (in 1939) produced a dual-phase transition through the fourth systemic war (the Second World War, 1939-1945), the core of the System (Europe) was significantly more (internally) connected, than the non-core of the System. In response, and consistent with the second law of thermodynamics, the System simultaneously implemented two upgraded orders: (1) two dedicated non-anarchistic hierarchies in the core of the System, and (2) a first global order at a global scale of the anarchistic System. Both orders were complementary, and ensured a lower energy state of the (now global) System.

KEY WORDS *Fourth systemic war, Core, Non-core, second law of thermodynamics, Dedicated non-anarchistic hierarchies, First global order.*

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), states in the core of the System (Europe), expanded their power and influence outside the core and to that end established state-like structures in the non-core, to ensure political control over, and efficient exploitation of non-core territories.

The core and non-core developed at different speeds, had different levels of connectedness, and therefore produced different levels of free energy (tensions).

Consistent with the requirements of the second law of thermodynamics, during the fourth systemic war (the Second World War, 1939-1945) the global System simultaneously implemented two upgraded orders in the System, respectively in the core, and at a global scale of the System (encompassing the core and non-core). The global order that was implemented at a global scale of the System (the United Nations) was based on less comprehensive organizational arrangements, than the arrangements of the two dedicated non-anarchistic hierarchies that were implemented in the core of the System (Europe); the connectivity of a (sub)system determines the required level of (sub)order. The demands of the second law of thermodynamics could be met with a lower level of order in the non-core than in the core of the System.

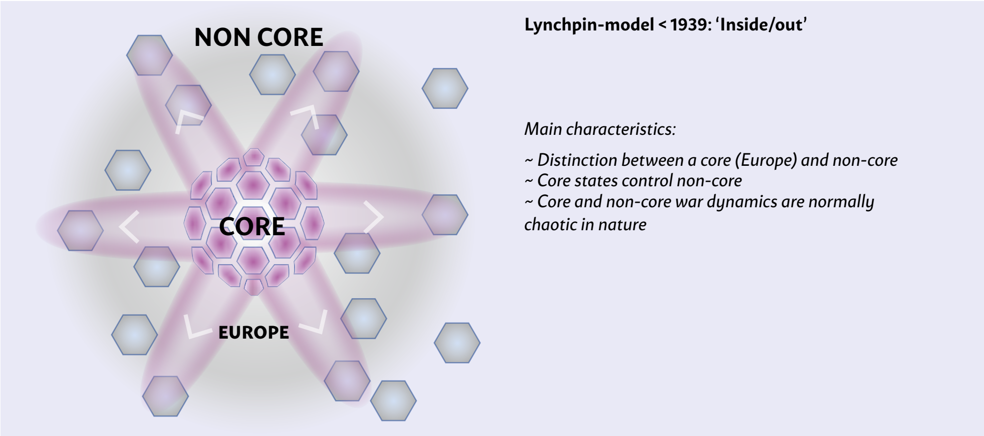


Figure 121 *In this figure the linking of core and non-core is shown before the collapse of the System in 1939. Core-states controlled (most of) the non-core territories through colonies they had acquired.*

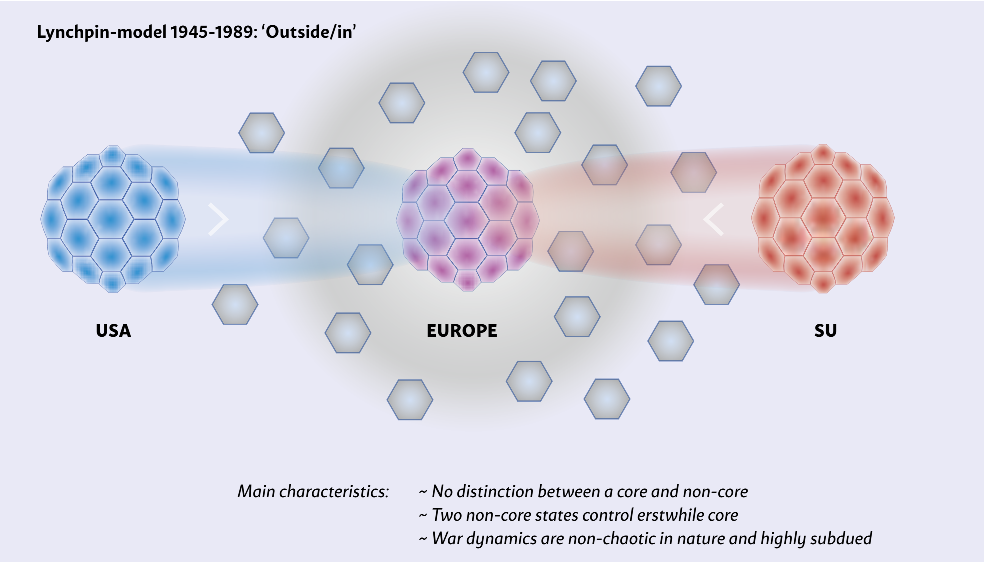


Figure 122 *In this figure the linking of the 'European order' - consisting of two dedicated non-anarchistic hierarchies, respectively controlled by the United States (the Western hierarchy) and the Soviet Union (the Eastern hierarchy) - to the first global order is shown. Both hierarchies (the European order) were integral parts of the first global order; core and non-core had merged through the fourth systemic war (the Second World War, 1939-1945).*

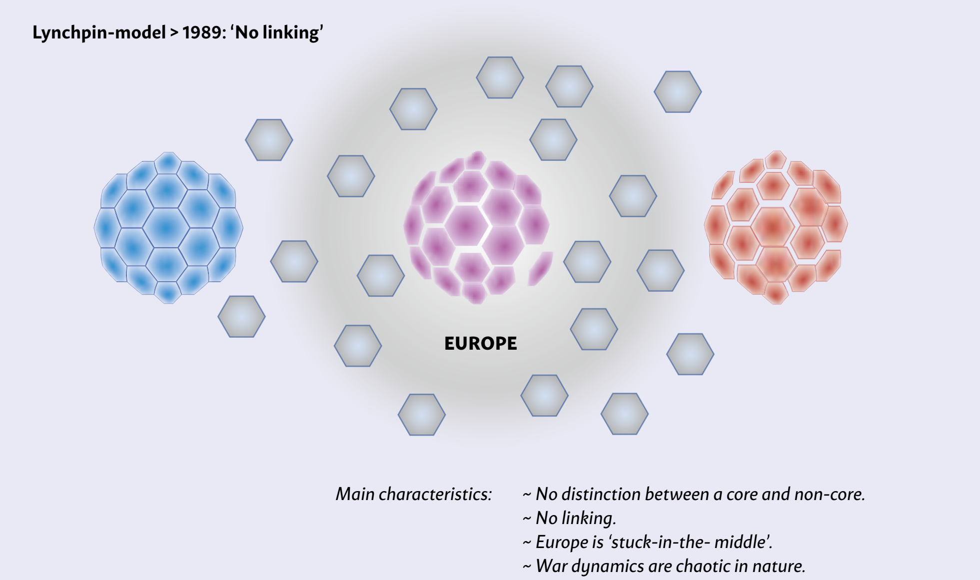


Figure 123 *In this figure the System is shown after the collapse of the Eastern hierarchy, and the 'abolition' of the lynchpin model (1945-1989). European states and the European Union are stuck-in-the-middle, and are 'on drift'.*

306 The expansion of the core of the System started with an extension of European structures and dynamics to the non-core of the system, and ultimately resulted in the implementation of an integrated global order.

KEY WORDS *Expansion, Integration, Core, Non-core, Singularity dynamic, Connectivity, Fusion, SIE.*

During the unfolding of the finite-time singularity accompanied by four accelerating cycles (1495-1945), initially European states controlled and shaped the expansion of the core of the System to the non-core. In order to ensure and improve their ability to fulfill their basic requirements, European states expanded to the non-core, by politically controlling and economically exploiting non-core territories. Expansion contributed to the ability of states to produce, mobilize, and deploy destructive energy, as demanded by the singularity dynamic.

However, expansion to the non-core also led to the 'export' of European rivalries to the non-core, and contributed to the perceived need of European states to implement state-like structures outside the core. These structures were responsible of political control and economic exploitation of non-core territories.

Rivalries between European states outside the core also contributed to tensions in the core itself. The interactions between the core and non-core intensified over time. Non-core state-like structures also developed their own interests and autonomous interactions with other non-core states. Some non-core states became increasingly autonomic and, to better ensure the fulfillment of the basic requirements of their 'own' populations, resisted the demands of their colonizers. In some cases, this led to the independence of non-core states. The independence of the United States (1776) is the most notable example of such a process.

It turned out to be just a matter of time before independent non-core states acquired Great Power status. Because of the continuously growing connectivity and interdependence of what would become a global system, the System outside the core also autonomously generated its own rivalries, tensions, and war dynamics; the difference (in structures and dynamics) between core and non-core progressively faded.

What started as an extension of the European System, powered by the finite-time singularity dynamic that developed and unfolded in Europe during the 1495-1945 period, the core and non-core of the System eventually merged through the fourth systemic war, (the Second World War, 1939-1945). The fusion of core and non-core was embedded in the (now global) System, through the implementation of the first global order (the United Nations), of which the dedicated non-anarchistic hierarchies that were implemented in Europe were integral components.

Below figures show how the core of the system (Europe) expanded, how Europe was increasingly enveloped by autonomous dynamics of the non-core, and how Europe eventually became embedded in and became an integral part of the global order that was established, in compliance with the second law of thermodynamics.

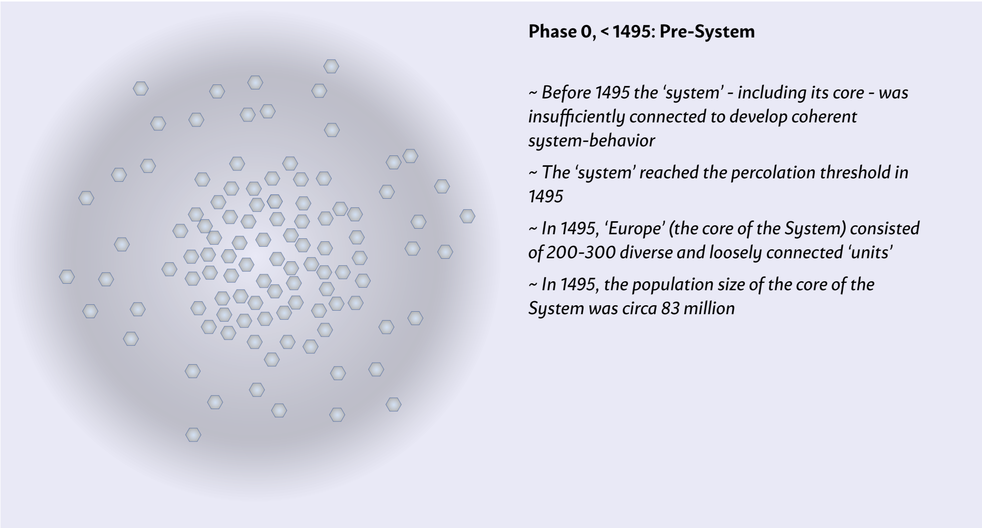
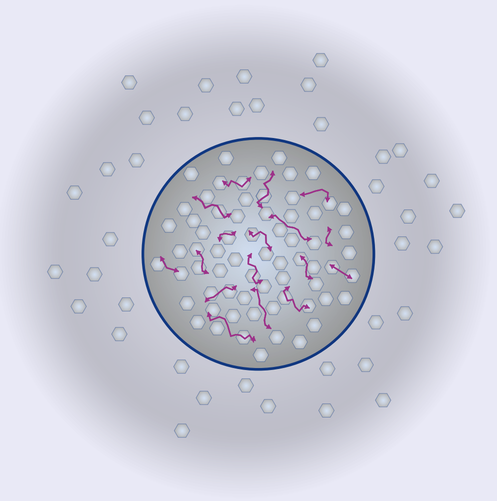


Figure 124 *Phase '0' SIE.*



Phase I, Start 1495: Core-formation and integration

~ Starting in 1495 a finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) unfolded in the System

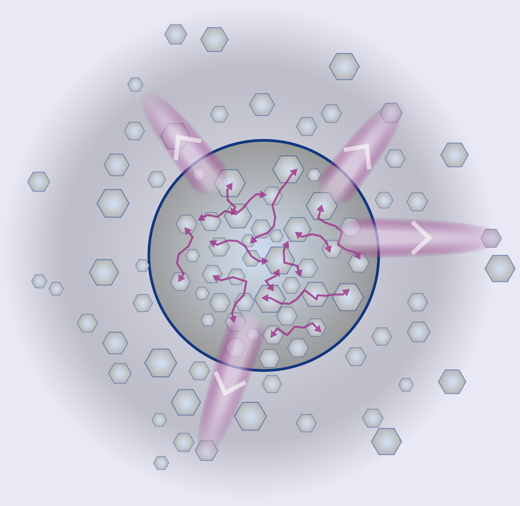
~ The System became critical for the first time in 1618

~ By means of systemic wars free energy (tensions) was put to work to implement upgraded orders

~ Population growth powered the finite-time singularity dynamic, and vice versa

~ The number of units in the System decreased, and (increasingly) crystallize in fractal structures

Figure 125 *Phase I SIE.*

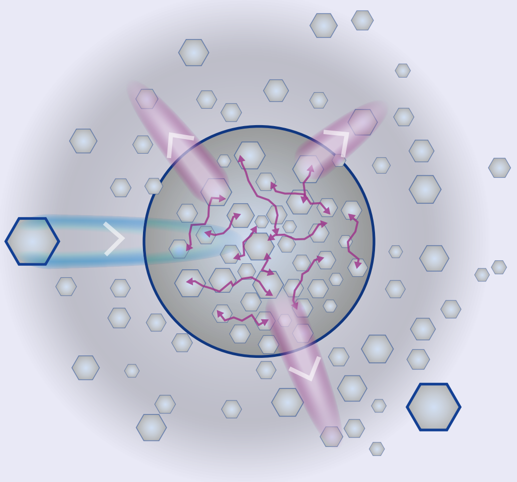


Phase II, 1812 > Core expansion and exploitation

~ Core states acquire political control over non-core territories to expand their power and to exploit these territories

~ In 1812 the first Great Power war with an non-core state takes place outside the core (the 'War of 1812', nr. 88) (The 'War of the American Revolution' (nr. 81) does not qualify as such, and must be considered an exception)

Figure 126 *Phase II SIE.*



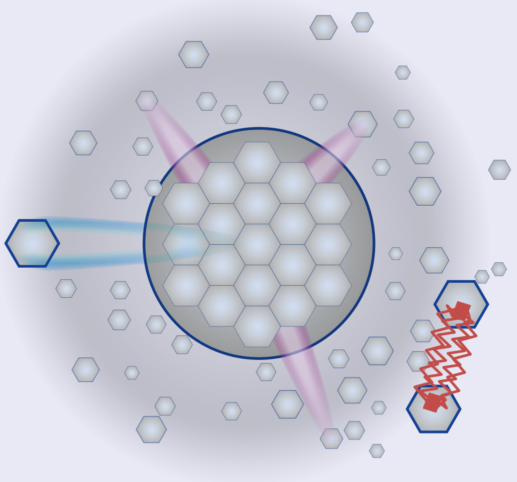
Phase III, 1914/1917: Non-core involvement in core-affairs

~ Non-core states increasingly interact, without (direct) core-involvement

~ Non-core states acquire Great Power status: the United States in 1898, Japan in 1905 (until 1945)

~ The United States gets directly involved in the third systemic war (the First World War, 1914-1918), in the core of the System

Figure 127 *Phase III SIE.*



Phase IV, 1931: Autonomous non-core Great Power war dynamics

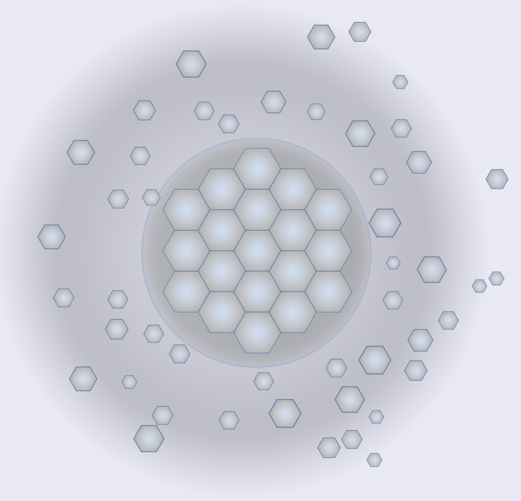
~ The 'Manchurian war' (nr. 109, start 1931) is the first 'autonomous' non-core Great Power War (involving Japan and China)

~ The core (Europe) has become 'absolute' robust, and structurally stable

~ In 1939, Europe consisted of 25-30 highly standardized states

~ In 1939, the population size of the core of the System was circa 544 million

Figure 128 *Phase IV SIE.*



Phase V, 1941: Globalization of the System and merging of core and non-core

~ In 1939, the core of the System (Europe) reached the critical connectivity threshold, collapsed, became critical and produced a systemic war.

~ In 1941 issue and war clusters of the core and non-core connected: the System became critical at a global scale.

~ By means of the fourth systemic war (the Second World War, 1939-1945) core and non-core merged.

~ The fourth systemic war constituted a dual-phase transition that resulted in the simultaneous implementation of two dedicated hierarchies in the core of the System, and a first global order at a global scale.

~ The distinction between core and non-core had lost its meaning.

Figure 129 *Phase V SIE.*

307 Integration and expansion of the System were closely related coevolutionary dynamics.

KEY WORDS *Intrinsic incompatibility, Connectivity, Security, Anarchy, second law of thermodynamics, Free energy, Lower energy state, Survival, Acceleration, Oscillation, Critical connectivity threshold, Dual-phase transition, Core, Non-core, 1939, 1941, Criticality, Fourth systemic war, Dual-phase transition, Dedicated non-anarchistic hierarchies, First global order, Integration, Expansion, second law of thermodynamics, SIE.*

As a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems, the System produced free energy (tensions). The second law of thermodynamics applies to the free energy that is produced by the anarchistic System. In accordance with the second law of thermodynamics, the free energy (tensions) in the System was periodically put to work (through systemic wars) to implement upgraded orders that allowed for lower energy states in the System. Lower energy states in the System (lower tension levels) were required to ensure that states and their populations in the anarchistic System could fulfill their basic requirements and survive.

Application of the second law of thermodynamics, in combination with a number of other deterministic laws and mechanisms that applied, the anarchistic System during the 1495-1945 period, produced a finite-time singularity dynamic accompanied by four accelerating cycles. The four cycles – oscillations – are a consequence of delayed responses of the System to the increasing disorder that developed during the life span of relatively stable periods; the acceleration of the cycles can be attributed to the accelerating amounts of free energy the anarchistic System produced.

In 1939 the anarchistic System reached the critical connectivity threshold (the singularity in finite time), produced infinite amounts of free energy (tensions), and collapsed as a consequence. It was no longer possible to implement an upgraded order in the anarchistic System, that allowed for a lower energy state of the System. In response, and consistent with the second law of thermodynamics, the System produced a dual-phase transition through the fourth systemic war (the Second World War, 1939-1945). The dual-phase transition resulted in the simultaneous implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a first global order at a global scale of the System. These orders satisfied the demands of the second law of thermodynamics.

The synchronized phase transitions in Europe and at a global level accomplished by the fourth systemic (first global) war were the outcome of the finite-time singularity dynamic, accompanied by four cycles that unfolded during the 1495-1945 period. During the unfolding of the finite-time singularity dynamic, developments inside and outside the core (Europe) were closely related.

Whereas in the core of the anarchistic System (Europe) orders were periodically upgraded through systemic wars (consistent with the demands of the second law of thermodynamics), states making up the core at the same time expanded their political control and exploitation of non-core territories. Integration and expansion of the core were coevolving processes, both powered by the finite-time singularity dynamic which was accompanied by four accelerating cycles (1495-1945).

The core of the System produced accelerating – and in 1939 infinite – amounts of free energy (tensions).

In the core, this energy was put to work by four systemic wars to implement increasing levels of order. Outside the core, free energy was put to work to increase the connectivity of the still loosely connected system. The structures and connections that were formed outside the core of the System initially constituted extensions of the core of the System. The increasing political control of European states over non-core territories is indicative of this phenomenon. "European states held political control over about 7 percent of the earth's land in 1500, 35 percent in 1800, and 84 percent in 1914", as Tilly observes (70).

To enhance – effectuate – political control over non-core territories, European states implemented state-like structures in those territories, that increasingly resembled 'states', that also generated their own (state-like) internal and external dynamics.

In a number of cases these states structures disconnected from their European 'controller', and further developed autonomous dynamics and interests. The United States (1776) is the preeminent example.

Initially the tensions outside the core originated in the core of the System, and were 'exclusively' fed by the finite-time singularity dynamic in the core. At a later stage, however, the increasingly connected system outside Europe (in the non-core) also developed its own issues and tensions, that contributed to the total level of free energy and tensions in the increasingly global System.

In 1939, when the core of the anarchistic System reached the critical connectivity threshold, the core produced infinite amounts of free energy (tensions), implying that in Europe, the System (theoretically) produced systemic wars at an infinite frequency and with infinite severities. Because of the by then already highly-connected and integrated nature of the increasingly global system, the infinite amounts of free energy produced in the core (Europe) also affected issues and tensions (and dynamics) outside the core. There was, so to say, an overflow of tensions, from core to non-core.

The sequence and impact of events during the fourth systemic war (The Second World War, 1939-1945) show that the System by then had reached a global percolation condition, a vulnerable issue cluster that spanned the global system.

Japan's attack on Pearl Harbor (December 1941) pushed the System from European to global criticality, and escalated a systemic war in Europe to a global level. Germany was instrumental in this unavoidable (up)scaling.

Japan's attack on the United States at Pearl Harbor (7 December 1941) triggered a declaration of war by Germany on the United States (11 December 1941), a trigger for the United States to actively engage in both theatres of war (Europe and Asia), that until then had evolved more or less independently. Given the connectedness, and imminent criticality of the global System, such a trigger – that would activate a globally percolated vulnerable cluster – was only a matter of time.

This cascade of events connected and activated both clusters (core and non-core), resulting in a globally connected System and a systemic war with a global reach. Globalization of the System – and a first world war – was now a fact.

The fact that the System was critical at a global level, implied that the upgraded order(s) that had to be designed and implemented (through the now global fourth systemic war), had to encompass the (now) global System, to be able to meet the requirements of the second law of thermodynamics.

The fact that the core of the System (Europe) was significantly more connected, and already had a significant level of order (the outcome of three preceding systemic wars, that only concerned Europe), contrary to the non-core which still lacked a coherent order, meant that two complimentary orders had to be implemented simultaneously, that addressed the specific (connectivity) conditions of the core and non-core.

The fourth systemic war (the Second World War, 1939-1945) produced, what I qualify as a dual-phase transition; through the fourth systemic war, simultaneously two dedicated non-anarchistic hierarchies were implemented in the core of the System (Europe), and a first global order (than included both hierarchies) at a global scale of the (now global) anarchistic System.

The European order and the global order that were implemented through the fourth systemic war were complementary; the global order could not have been established and effective if the tensions in the core were not neutralized. The opposite is also the case: The European order could not have been established and effective if tensions outside the core were not sufficiently lowered. The upgraded order in the core could only function if both internal and external tensions were sufficiently neutralized.

If the now globalized system lacked a certain order that allowed for a lower energy state at a global level, tensions produced outside of Europe would have affected the functioning of the upgraded order in the core; extensive connections still existed between European states and non-core states (especially their colonial territories).

The second law of thermodynamics solved this 'dilemma' by simultaneously implementing two complementary and integrated orders in respectively Europe (the core of the System) and at a global level of the anarchistic System.

The simultaneous process of integration and expansion shaped by a highly deterministic finite-time singularity dynamic accompanied by four accelerating cycles, that unfolded in the System during the 1495-1945 period, in fact constitutes a next level of SIE. Through the dual-phase transition, the core and non-core merged, and this distinction lost most of its meaning.

308 Because the System had reached the connectivity threshold at a global scale, and became critical for the first time at a global scale in December 1941, in order to meet the requirements of the second law of thermodynamics, a next upgraded order (also) had to be implemented at a global scale of System.

KEY WORDS *Connectivity threshold, Criticality, second law of thermodynamics, Core, Non-core.*

The unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles during the 1495-1945 period led to the implementation of three successive upgraded orders in the core of the System (Europe), but also contributed to the 'accompanying' expansion of Europe states to non-core territories, in their efforts to maximize the fulfillment of their basic requirements and their power and influence (in- and increasingly outside Europe). Eventually, the non-core developed similar structures and dynamics as the core (Europe). Initially these dynamics were extensions of the rivalries and dynamics in the core of the System, between European states, however,

it was just a matter of time before the non-core started to develop autonomous rivalries, tensions and dynamics that further contributed to the connectivity of the 'system' at a global scale.

In 1939, the core of the system (Europe) became critical and produced a systemic war (1939-1945). In 1941, criticality of the System was scaled up to a global level as a consequence of the combined effects of the autonomous rivalries and dynamics in the non-core and the critical condition of the core.

Because of its now global scale, the energy state of the System could not be reduced any longer by only upgrading the European order; the second law of thermodynamics demanded the simultaneous and synchronized implementation of a global order and an upgraded order in the core of the System. The levels of both orders had to meet the specific requirements of the part of the System with which they were concerned.

309 Integration of the core of the System (Europe), expansion of core states to non-core-territories, the development of autonomous non-core dynamics, and the eventual merging of core and non-core through the fourth systemic war (the Second World War, 1939-1945), were closely related phenomena. Both processes – integration and expansion – accelerated with the same rate.

KEY WORDS *Core, Non-core, Integration, Expansion, Linkage, First global order, Dedicated non-anarchistic hierarchies, Phases of expansion.*

The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) was a European dynamic; European rivalries powered it, despite some non-European involvement in European affairs starting in 1914. Integration of the European core, the simultaneous expansion to the non-core, and the ultimate merging of core and non-core in an integrated System with a global scale, went hand in hand. The ultimate merging of core and non-core was accomplished through the fourth systemic war (the Second World War, 1939-1945), when simultaneously two dedicated non-anarchistic hierarchies were implemented in the core of the System (Europe), and a first global order at a global scale of the System. Both orders were complementary and inseparably linked; the linkage of both orders was accomplished through the United States and the Soviet Union, two 'superpowers' with global reach, that also had acquired control over the dedicated non-anarchistic hierarchies that were implemented in Europe (respectively over the Western and Eastern hierarchy).

Regarding the expansion of the core it is possible to distinguish five phases, as specified in the table below:

Five phases of expansion from a European to a global System

Phase	Timing	Characteristics	Triggers
(I) Core formation and integration: Initially (1495-1812): 'Internal core dynamics only'	Starting 1495	During the period 1495-1812 all Great Power war dynamics still take place within Europe, the core of the System.	During the period 1495-1812; internal core dynamics only.

Five phases of expansion from a European to a global System			
(II) Core expansion: 'Power projection outside Europe'	Starting 1812	European Great Powers become involved in or start wars outside of Europe.	The War of 1812, 1812-1814, war 88 in Levy's dataset marks the beginning of this phase. Other wars that are part of phase two are 97, 99, 104, 105, 110, and 112 (38).
(III) Autonomous non-core formation and involvement in European affairs	Starting 1914	Non-European Great Powers become involved in European war dynamics.	The United States' and Japan's involvement in the First World War (1914-1918) mark the beginning of this phase.
(IV) Non-European powers autonomously produce their own war dynamics	Starting 1931	Non-European Great Powers initiate their own Great Power wars outside of Europe, without the direct involvement of European Great Powers.	The Manchurian War (109, involving Japan and China) marks the beginning of this phase.
(V) Globalization of the System and merging of core and non-core	Starting 1941	War dynamics become connected on a global scale.	Japan attacks the United States (Pearl Harbor, 1941), and Germany (ally of Japan), declares war on the United States, connecting war clusters in Europe and Asia.

Table 102 *This table shows the five expansion-phases of the System that can be determined during the unfolding of the finite-time singularity dynamic (1495-1945).*

310 The process of expansion accelerated during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945).

KEY WORDS *Expansion, Acceleration, Singularity dynamic, Globalization point.*

A closer look at the start dates of the respective expansion phases shows that the process of expansion accelerated over time. The finite-time singularity dynamic powered not only European integration, but also the global expansion of the System.

The figure below shows when distinct new phases started in the process of expansion of the core (Europe). The data shows that new phases started at an accelerating pace, until the System eventually in 1941 reached the 'globalization point', and globalization of the System (from a security and war dynamics perspective) was a fact.

Accelerating expansion of the System (1495-1941)		
Phase	Start date	Time to globalization (1941 - start date)
(I) Core formation and integration	1495	446
(II) Core expansion	1812	129
(III) Autonomous non-core formation and involvement in European affairs	1914	27
(IV) Non-European powers autonomously produce their own war dynamics	1931	10
(V) Globalization of the System and merging of core and non-core	1941	0

Table 103 *This table shows the accelerating expansion of the System (1495-1941).*

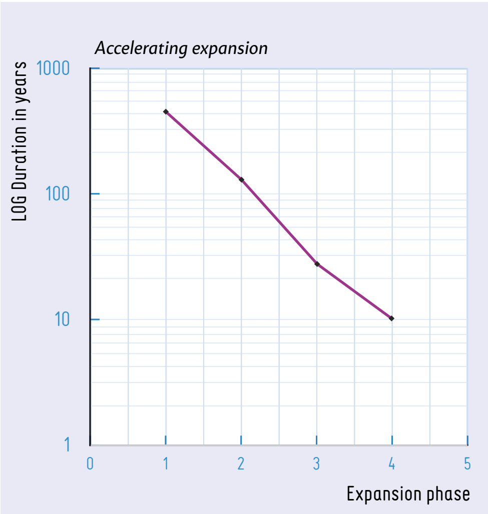


Figure 130
This figure shows accelerating shortening of the life span of successive phases.

311 The process of integration of the core of the System (Europe), and its expansion to a global scale (1941) accelerated at the same rate; the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) 'powered' the closely related processes of integration and expansion.

KEY WORDS *Integration, Expansion, Core, Non-core, Singularity dynamic, Synchronization.*

Analysis of the development and acceleration of the life spans of successive cycles and expansion phases, respectively concerning the integration of the core of the System (Europe) and the core's (Europe's) outward expansion to the non-core, show that both processes accelerated with the same rate.

Cycles and phases related to the process of integration and expansion (SIE) of the anarchistic System (1495-1945)				
		Integration T(c) = 1939		Expansion T(c) = 1941
Cycle/Phase	Start T	T(c) - T	Start T	T(c) - T
1	1495	444	1495	446
2	1648	291	1822	129
3	1815	124	1914	27
4	1918	21	1931	10

Table 104 *In this table I show how I determined the duration of successive (integration) cycles and expansion phases. The critical time (T(c)) for the process of integration is the timing of the anarchistic System's collapse in 1939; The critical time for the process of expansion is 1941, when the System 'globalized' through the global linkage of war and issue clusters.*

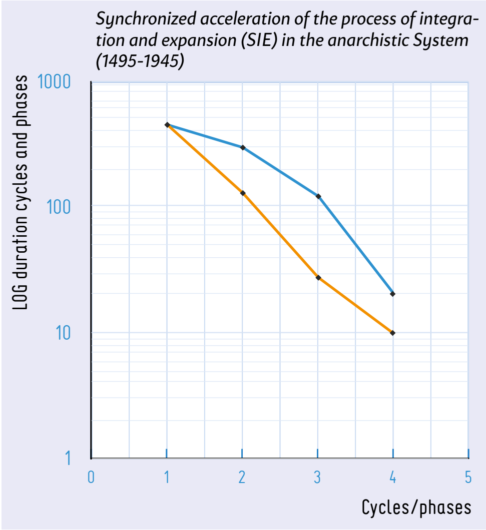


Figure 131
This figure shows the acceleration of the processes of integration (blue) and expansion (orange) in the anarchistic System. The data points related to the process of integration (blue) depict the life-spans of successive cycles (that can be considered 'phases of integration' in the core). The data points related to the process of expansion (orange) depict the duration of the four phases that can be distinguished in the process of expansion of the core to the non-core. The figure shows that both processes accelerated at about the same rate. It not only confirms the close relationship between both processes, and was to be expected given the fact that both processes originated in the core of the System (Europe), and that the pace of these processes is determined by the level of connectivity of the core, itself a function of its population size. Population growth, in other words, set the pace for integration, as well as expansion in the System. The correlation coefficient of the series is 0,92.

The synchronized acceleration of both processes was to be expected, given the fact that both processes are 'products' - dynamics - of the 'same' finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period.

Connectivity (growth) of the System was (and still is) the driver (control parameter) of the anarchistic System, that determined its pace of life, including the processes of integration and expansion.

312 The fraction of expansion wars during successive cycles of the first finite-time singularity dynamic (1495-1945) increased exponentially.

KEY WORDS *Singularity dynamic, Cycles, Expansion, Expansion wars, Fraction of expansion wars.*

During successive cycles of the first finite-time singularity dynamic (1495-1945) the System produced respectively 45 - 34 - 21 - 6 non-systemic wars (total 106). Respectively 0 - 1 - 4 - 4 of these wars qualify as expansion wars.

During successive cycles of the first finite-time singularity dynamic, the fraction of expansion wars increased exponentially.

The correlation coefficient of the number of wars during successive cycles, and the fraction of expansion wars is - 0,93.

Proportion of expansion wars (1495-1945)

Cycle	Non-systemic wars (total)	Expansion wars	Proportion (Expansion wars)
1	45	0	0.000
2	34	1	0.029
3	21	4	0.190
4	6	4	0.667

Table 105 *This table shows the proportion of expansions wars during successive cycles of the first singularity dynamic (1495-1945).*

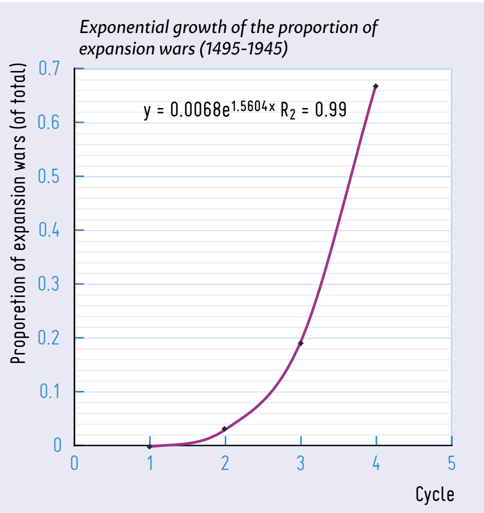


Figure 132
This figure shows the exponential growth of the proportion of expansion wars Nog te plaatsen during successive cycles of the first finite-time singularity dynamic (1495-1945).

I argue that the growth rate of the fraction of expansion wars is related to the increasing robustness of successive cycles of the first finite-time singularity dynamic, and the accelerating expansion of the System. I assume that the increasing connectivity (population growth) of the System is the 'driver' of these dynamics.

313 Population growth, integration and expansion of the core of the System were mutually reinforcing processes, shaped by the finite-time singularity dynamic accompanied by four accelerating cycles that unfolded in the System during the 1495-1945 period.

KEY WORDS *Population growth, Integration, Expansion, Core, Non-core, Cycles, Acceleration, SIE, Reinforcing dynamics.*

The 1495-1945 period is a distinct phase in a long-term and still unfolding process of social integration and expansion (SIE) of humanity and social systems, that started when the first humans chose to cooperate and form tribes to improve their ability to fulfill basic requirements and enhance their survival changes.

During the 1495-1945 period, interactions between 'groups' of humans and later states, produced a self-organized finite-time singularity dynamic accompanied by four accelerating cycles, that eventually resulted in a dual-phase transition (through the fourth systemic war, the Second World War, 1939-1945) that led to the simultaneous implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a first global order at a global scale of the System.

The self-organized finite-time singularity dynamic 'emerged' from (1) the 'collective' urge to survive of growing populations that (increasingly) organized in 'clusters' (states), (2) the free energy (tensions) that was produced (as a byproduct) of the interactions between states in the anarchistic System, and (3) a number of laws (including the second law of thermodynamics) that applied to the free energy that was produced and to their interactions.

The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) balanced the performance and evolvability of the anarchistic System; by periodically producing upgraded orders that allowed for lower energy states in the System.

The finite-time singularity dynamic ensured that growing populations of states – population growth – could be accommodated in the anarchistic System, by ensuring that their basic requirements could be 'collectively' fulfilled. At the same time as the singularity dynamic fulfilled this function, population growth ensured the further development and unfolding of the finite-time singularity, by ensuring that accelerating levels of free energy were produced, and could be put to work to (in time) upgrade the order of the anarchistic System.

The finite-time singularity dynamic resulted in the integration of states in Europe, because the second law of thermodynamics demanded increasing levels of order to allow for lower functional energy states in the System. It also led to the expansion of the core of the System (Europe) to the non-core, in continuous efforts by European states to improve their ability to fulfill their basic requirements and to increase their power and influence. Integration and expansion, both powered by the singularity dynamic, and the incompatibility between connectivity and anarchy, were complementary, mutually-reinforcing dynamics.

The increasing levels of order that were implemented during the unfolding of the finite-time singularity dynamic, not only accommodated population growth, and resulted in the forming and integration of states in Europe, but also resulted in a process of expansion of the core of the System (Europe) to the non-core, in continuous efforts of European states to improve their ability to fulfill their basic requirements, and increase their power and influence.

Population growth, integration and expansion – powered by the singularity dynamic, and the increasing incompatibility between (increasing) connectivity and anarchy – were complementary mutually reinforcing dynamics.

314 The upgraded orders that were implemented through the fourth systemic war (the Second World War, 1939-1945), respectively in Europe and at a global scale of the System, complemented each other: compliance with the requirements of the second law of thermodynamics required 'synchronized' implementation.

KEY WORDS *Forth systemic war, Globalization point, 1941, Synchronization, Upgraded orders, Linkage.*

In December 1941, issue and war clusters that had developed in Europe and Asia merged and led to an extension of the critical condition from the core of the System (Europe) to a global scale. At that point, the core and the non-core of the System merged into a global System.

To allow for a lower energy states in the (now) global System, and to ensure compliance with the second law of thermodynamics, two upgraded orders had to be implemented simultaneously in Europe (until then the core of the System), and at a global scale of the System. Two different – but complimentary – orders were required because of the difference in connectivity in Europe and at a global scale of the System. A single viable order could not be designed and implemented that could simultaneously and effectively 'address' the two fundamentally different levels of connectivity, and amounts of free energy (tensions) that were produced as a consequence.

Europe (the erstwhile core) required the implementation of dedicated non-anarchistic hierarchies to reduce the free energy (tensions) it produced given its high connectivity, while at a global level the implementation of such a high level of order was not necessary and not feasible. The second law of thermodynamics ensured the implementation of a customized solution: dedicated non-anarchistic hierarchies in Europe, and a less comprehensive order at a global scale of the anarchistic System.

The required 'linkage' - coordination - between orders was ensured by the dominant roles the United States and the Soviet Union played in both orders.

315 The fourth systemic war (the Second World War, 1939-1945) marks the actual globalization of the System.

KEY WORDS *Singularity dynamic, Fourth systemic war, Dual-phase transition, Merging, Dedicated non-anarchistic hierarchies.*

The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) consisted of two closely related and interacting dynamics: the integration of the core of the System and its simultaneous expansion to non-core territories; eventually core and non-core merged.

The merging of the core and non-core of the System was accomplished – implemented – through a dual-phase transition in which the fourth systemic war (the Second World War, 1914-1945) was instrumental. The dual-phase transition resulted in the simultaneous implementation of (1) two dedicated non-anarchistic hierarchies in the core of the System, that later merged into one when the Eastern hierarchy collapsed in 1989, and (2) the first global order at a global scale, that also encompassed the two dedicated hierarchies that were implemented in its core.

Through the fourth systemic war the core and non-core of the System merged, a process that marks the actual globalization of the System.

Figure 22, derived from Levy's dataset, shows how the complementary integration and expansion processes – both components of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) – unfolded.

Symptoms of these dynamics were also noticed by Tilly, but because the deterministic domain was not yet identified could not fully be made sense of (70). Tilly observed, "The cracks in World War I's settlements, indeed, forecast the fissures that opened up at the end of World War II. By that time the world-wide reach of the formerly European state system, and the emergence of such geographically and politically eccentric powers as Japan and the United States put great stress on a set of relations that had worked more or less well for four centuries."

316 Preceding the dual-phase transition the System experienced through the fourth systemic war (the Second World War, 1939-1945), European states were the 'lynchpins' between the core and the non-core of the System. Through these lynchpins the rivalries, dynamics, and development of the core and non-core were (partially) synchronized.

KEY WORDS *Fourth systemic war, Dual-phase transition, Merging, Core, Non-core, Linkage, Lynchpins.*

The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) in fact consisted of two synchronized 'components'; a process of integration concerning the core and 'engine' of the System (Europe), and a process of expansion of core-states to non-core territories, they increasingly submitted to their control, but that at the same time developed their own autonomous rivalries and dynamics.

The interests of core states in non-core territories – and their efforts to control and exploit these non-core territories – caused the core and non-core to become increasingly connected. According to Tilly, "European states held political control over about 7 percent of the earth's land in 1500, 35 percent in 1800, and 84 percent in 1914" (70).

However the increasing connectedness of core and non-core (increasingly) functioned in two directions: At the same time as core-states increased their political control, non-core states (like the United States and Japan) developed their 'own' connections and dynamics with other non-core but also with core states, respectively leading to Great Power wars between non-core states (involving Japan), and to involvement of the United States (1917) in the third systemic war (The First World War, 1914-1918). Core and non-core became inseparably linked.

317 Through the dual-phase transition (the fourth systemic war, the Second World War, 1939-1945) the United States and the Soviet Union became the lynchpins between the dedicated non-anarchistic hierarchies that were implemented in the erstwhile core of the System, and the first order that was implemented at a global scale. The United States and the Soviet Union 'synchronized' both orders.

KEY WORDS *Lynchpins, Fourth systemic war, Dual-phase transition, Dedicated non-anarchistic hierarchies, First global order, Core, Non-core.*

In order to comply with the requirements of the second law of thermodynamics, the System through the forth systemic war (The Second World War, 1939-1945) implemented simultaneously two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a first global order at a global scale of the System. Both orders were inseparably linked, and could not function without each other. Through both orders – the European order was an integral part of the first global order – the core and non-core of the

System in fact merged. The fourth systemic war marks the actual globalization of the System.

The synchronization of the core and non-core, preceding the dual-phase transition (1939-1945) was accomplished through the political control European states had acquired over non-core territories.

The United States and the Soviet Union became the 'lynchpins' between the European order and the first global order. Linkage was achieved through the political control, both 'superpowers' with global reach (the United States and the Soviet Union) had acquired during the fourth systemic war (the Second World War, 1939-1945), over respectively the Western and Eastern hierarchy; the two dedicated non-anarchistic orders that formed the European Order.

318 The future of the European Union – of Europe – is uncertain.

KEY WORDS *European Union, EU, Basic requirements, Economies of scale and scope, Resumption of chaotic war dynamics, Security dilemma.*

Eventually in 1989 the Eastern hierarchy and collapsed as a consequence of a lack of internal balance that could adequately ensure the fulfillment of basic requirements of the populations of these structures. In response, the Soviet Union, an extension of Russia, retracted to its core (Russia), in efforts to re-establish a viable internal balance in (at least) Russia itself. At the same time Eastern European states 're-nationalized', and a number of these states joined the Western hierarchy. The extended Western hierarchy stepped up its pace of internal integration, through the (further) establishment of integrative structures that superseded state structures, and could (better) exploit economies of scale and scope that presented themselves.

Because the collapse of the Eastern hierarchy and the Soviet Union also brought an end to the intense rivalry between the United States and the Soviet Union, the United States retracted military capabilities from Europe, it had preventively deployed in Europe to counter Soviet-threats.

It can be argued that the expansion of the Western hierarchy, following the collapse of the Eastern hierarchy (1989), was a logical – and unavoidable – response of the System, given the long-term development of SIE in Europe through the finite-time singularity dynamic accompanied by four accelerating cycles, that unfolded during the 1495-1945 period.

However, the end of the intense rivalry between the United States and the Soviet Union, had more and wider consequences; it brought an end to the second exceptional period (1953-1989) during which the non-systemic war dynamics of the global System were subdued. In 1989 the global System could – and did – resume chaotic non-systemic war dynamics, but now – for the first time – at a global scale of the System.

These chaotic dynamics expose(d) the still fragile integrative structures in Europe to increasing pressures, expose(d) a number of shortcomings, and shed doubts by member states about the European Union's viability.

Europe was – and still is – 'stuck in the middle'; state structures are weakened (as a consequence of the transfer of certain authority to 'Europe'), while European integrative structures are still not fully developed; as a consequence, states and the European Union are vulnerable.

The question is, if the European Union – Europe – cannot adequately 'handle' the volatile developments it is confronted with, what 'scenario' - what changes - will bring an end to the inadequate 'stuck in the middle' condition of Europe: further integration of (parts) of the European Union, renationalization, or a combination of both.

If states renationalize, the next question is, if this implies that in (parts of) Europe, the security dilemma – anarchy – will shape relations between (certain) states again. If this is the case, the question is how the free energy that is produced, will (and can be) released; by non-systemic or systemic wars, or through a combination of these types of wars. Tensions can only be released by non-systemic wars, if the robustness of the System (in the regions it concerns; a function of its (regional) connectivity) is not infinite (as was the case shortly before the outbreak of the fourth systemic war, the Second World War, 1939-1945).

319 A number of issues can be identified that contribute to the buildup of tensions in the System, and constitute the engines of the second finite-time singularity dynamic that is now unfolding (1945-...).

KEY WORDS *Issues, Rivalries, Second singularity dynamic, Singularity dynamic, First Global order.*

These issues include: (a) rivalries between Russia and the erstwhile and extended Western hierarchy and its initial sponsor and guardian, the United States; (b) religious rivalries between states/regions in the Middle East that resemble the dynamics in Europe preceding and during the Thirty Years' War (1618-1648, the first systemic war); (c) rivalries between China and regional states and with the United States because China was not fully involved in the design and implementation of the first global order, and is ambivalent in respecting its arrangements; (d) local issues related to state structures that turned out not to be viable in the erstwhile non-core and collapsed; and (e) the ability of super national communities to mobilize and deploy destructive energy at a global scale by leveraging global mobility and the Internet, in efforts to undermine states, the international order, and other religions and ideologies. These issues are increasingly connected.

320 Our urge to survive produced the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), including its end – and intermediate – results.

KEY WORDS *Singularity dynamic, Acceleration, Free energy, Intrinsic incompatibility, Lower energy state, Intrinsic incompatibility, Population growth, Collapse.*

The urge of humans to survive and continuous population growth led to the formation of clusters and later, states, that became increasingly connected and produced increasing amounts of free energy. By cooperating – forming groups, including states – humans were better able to fulfill their basic requirements, and enhance their survival changes.

However, the (increasing) interactions between states and their populations also resulted in the production of increasing amounts of free energy (tensions); the production of free energy is a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems.

The second law of thermodynamics also applies to the free energy that is produced in the System; according to this law, free energy must be put to work to implement upgraded orders, that allow for lower energy states in systems. In the anarchistic System free energy (tension) is put to work through systemic war. A lower energy state is a prerequisite for the implementation of a relatively stable international order, that enables the fulfillment of basic requirements of states, and their further growth.

Because free energy (tensions) were produced at an accelerating rate, upgraded orders also had to be implemented at an accelerating rate.

By balancing performance and evolvability of the System, and producing upgraded orders, the singularity dynamic was instrumental in ensuring the collective survival of (growing) populations in states. Wars were integral components of the finite-time singularity dynamic.

However, when the anarchistic System reached the critical connectivity threshold in 1939, and produced infinite amounts of free energy (tensions) as a consequence, the anarchistic System could no longer produce an upgraded order (in the anarchistic) System that could restrain these tensions; as a result, the anarchistic System collapsed. In response, consistent with the second law of thermodynamics, the System produced a dual-phase transition through the fourth systemic war (the Second World War, 1939-1945). Through the dual-phase transition the System simultaneously implemented two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a (first) global order at a global scale of the System.

The upgraded orders the System produced, ultimately resulting in the implementation of non-anarchistic hierarchies in Europe, all served the same purpose, ensuring the survival of growing populations in an anarchistic system.

321 To avoid collapse, social systems must ensure a certain balance in the fulfillment of their basic requirements.

KEY WORDS *Basic requirements, second law of thermodynamics, Collapse, Dedicated non-anarchistic hierarchies, SIE, Ensuring balance, European Union, EU, Challenges, Chaotic war dynamics, Conditions for effective integration, Fragmentation, Brexit, Scenarios, Integration, Partial integration, Fifth systemic war, 2020, Second Singularity dynamic, Lower energy state.*

Initially the phase transition (the fourth systemic war, the Second World War, 1939-1945) produced two dedicated non-anarchistic hierarchies in Europe (designated the Western and an Eastern hierarchy), respectively dominated by the United States and the Soviet Union.

As described, the Western hierarchy 'absorbed' parts of the Eastern hierarchy after its collapse in 1989.

Implementation of the dedicated non-anarchistic hierarchies (1939-1945), and further consolidation in 1989, were consistent with demands of the second law of thermodynamics to ensure a lower energy state of the System, and can be considered a next step in a long-term process of social integration and expansion (SIE) in the contingent domain of the System.

In order to maintain viable and survive, social systems must fulfill a number of basic requirements, and ensure their 'balance'. Collapses of states and of the Eastern hierarchy show, that such a balancing act is not always successful, and cannot always maintained.

The collapse of the Eastern hierarchy was a consequence of the inability of the hierarchy to perform its functions. It collapsed as a consequence of internal unbalance. The internal unbalance of the Eastern Hierarchy was amplified by external pressures generated by its interactions and rivalries with the Western hierarchy.

The question now is if the European Union, the extended Western hierarchy that was created after the collapse of the Eastern hierarchy, can effectively deal with external pressures it has (now) to confront, can maintain its internal balance, and avoid collapse. A number of (recent) developments suggest that the European Union faces (in some respects) the same challenges as the Eastern hierarchy did shortly before its collapse in 1989.

To be effective as an integrated hierarchy (coherent social system), it must meet a number of conditions; including:

1 ***Share a number of basic values***

2 ***Define shared goals***
The components of the hierarchy (states) must have a shared understanding of the desired direction of development of the hierarchy.

3 ***Achieve consensus over its current condition and challenges***

4 ***Collectively define actions and priorities***

5 ***Ensure requisite variety***
Ensure that adequate responses to perturbations are available, in time.

The European Union does not meet these requirements; its current condition can be best described as 'stuck in the middle': The European is not an effective integrative structure, that can control its 'parts', and exploit economies of scale and scope the Union (potentially) offers; the European Union also lacks a clear (and shared) understanding of its 'place' in the System, as well as instruments to adequately address challenges it is (increasingly) confronted with. However, states – members of the European Union – in the meantime have transferred authority to the European Union, making them – as states – also less effective and more vulnerable. Whereas the aim of the European Union is (and must be) that one plus one is three, in case of the stuck in the middle condition, one plus one has become one and a half; the sum of the whole (the European Union) is less than the sum of its individual parts. The shortcomings of the European Union become increasingly evident, because of the 'chaotic' dynamics it is confronted with. These developments have the effect of a centrifugal force; a 'force' directed away from further integration, potentially causing the System to 'fragment'. Fragmentation leads to re-nationalization of states (Britain, Brexit, 2016), that then resume their typical 'nationalistic' dynamics.

The question is how this process could further unfold. I assume that in principal three scenarios are conceivable; these scenarios have in common that the stuck in the middle condition is resolved:

6 ***Further disintegration (fragmentation) of the European Union***
In case of this scenario, more states chose to re-nationalize, assuming that their basic requirements can be more effectively and efficiently fulfilled. The question is if – and to what degree – re-nationalization also implies re-activation of the security dilemma (at a certain stage), resulting in tensions (free energy) that at a certain point must be put to work to allow for a lower energy state of the System (consistent with the demands of the second law of thermodynamics). Another question is, if the connectivity of Europe – its robustness – enables non-systemic release of tensions (non-systemic wars) or that only systemic releases (systemic war) are possible (see scenario 3).

7 ***Partial disintegration of the European Union, followed by accelerated integration***
In case of this scenario, only a few states leave the European Union, and their departure allows the European Union to continue its integration at a faster pace.

8 ***Disintegration followed by integration, through systemic war***
In case of this scenario, the tensions that are produced in Europe as a consequence of the re-nationalization of states, and the re-activation of the security dilemma, are at a certain point put to work through systemic war, and result in the implementation of an upgraded order in Europe (EU 2.0). A variant of this scenario is, that (systemic) war outside Europe, triggers an upgrade of the European Union, because the shared challenge brings about favorable changes in the five conditions I discussed in this statement.

In part IV I discuss and predict the war dynamics and further development of the current (first global) order. As this study shows, the System produced – and I argue will also produce in the future – highly deterministic war dynamins, that self-organize(d) in a finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), and in a second singularity dynamic (1945-…).

This study suggests, that the System will become critical at a global level around 2020, and produce a fifth systemic war (duration circa 2,5 years), that will result in the design and implementation of the second global order. Presently the System is in the high-connectivity regime of the first relatively stable period (the international order provided by the United Nations) of the first cycle of the second finite-time singularity dynamic.

In the coming years (2016-2020, until criticality) states in the System become increasingly stable, as a consequence of the increasing connectivity of the network of issues in the System they are an integral part of. Instead of being released, tensions are now stored in the System, form a free energy release deficit, and crystallize in vulnerable issue clusters with fractal structures; percolation and criticality are a matter of time

The security dilemma and interacting self-fulfilling prophecies between states (also in this case) ensure the synchronization of the deterministic and contingent domains of the System.

The question is how the (contingent) developments regarding the (dis) integration of the European Union, in combination with other developments in the System, will further crystallize into vulnerable issue clusters that will eventually percolate the System, cause it to become critical and produce a systemic war; the purpose of the systemic war is – as I mentioned – to upgrade the order of the System, to allow for a lower energy state.

322 State-structures are challenged and will eventually be replaced by global networks of communities; a second finite-time singularity dynamic (1945-…) will be instrumental in this process.

KEY WORDS *State-structures, Global networks, Communities, Singularity dynamic, Basic requirements, Coevolution, Population growth, Collapse, United Nations,* *First global order, Non-anarchistic structures, second law of thermodynamics, Networks-of-networks, Optimization.*

State-structures are the product of the (first) finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period; state-structures and successive international orders coevolved, and were highly customized designs that also met very specific 'European' conditions.

A number of developments suggest that state-structures have increasingly become suboptimal organizational solutions to challenges populations confront in their (collective) efforts to fulfill their (often competing) basic requirements; these developments include:

1) The collapse of a number of states outside Europe, suggesting that these structures cannot always be maintained under conditions that prevail(ed) in those regions. Often these state-structures – customized solutions for European conditions during the 1495-1945 period (the unfolding of the finite-time singularity) – were forced upon these 'populations', by their colonizers and the international order (the United Nations), that legalized these 'new' states (consistent with the 'rules' of the international order, as designed and implemented by dominant states during the fourth systemic war, the Second World War, 1939-1945).

2) The high connectivity of the System that forced the System to regionally implement dedicated non-anarchistic structures, that were superimposed on state-structures, to decrease and control the free energy (tensions) that was (and could be) produced in the anarchistic System.
As a consequence of improvements in efficiencies of scale and scope, state-structures that were included in these dedicated hierarchies became increasingly obsolete; the implementation of two dedicated non-anarchistic hierarchies in Europe (through the fourth systemic war, the Second World War, 1939-1945) is the preeminent example of this – it seems unavoidable – growth dynamic. The implementation of dedicated non-anarchistic hierarchies is consistent with the requirements of the second law of thermodynamics, to lower the System's energy state and allow for structural stability and the fulfillment of basic requirements by states and hierarchies.

3) The inability of states to develop adequate responses to new threats by communities that exploit the interconnected network and global mobility to deploy destructive energy at a potentially worldwide scale to accomplish their ideological and political objectives. States are organized to attack, or defend themselves against, other states. Armies represent states, and their organizations and capabilities are optimized to fight other armies, not networks that exploit the societies these 'communities' aim to destabilize and destroy 'from within'.

These specific developments point to more fundamental trends:

a Population groups and communities actively search for organizational innovations that can better ensure the fulfillment of their specific basic requirements.

b The opportunities for efficiencies of scale and scope that the interconnected network and global mobility provide to individuals and communities.

c The nature of threats that states, populations, societies, and, increasingly, communities are confronted with have changed fundamentally from external state-versus-state threats to hybrid threats: A combination of synchronized internal and external threats by border-crossing networks that are increasingly empowered by the opportunities the Internet (world-wide communication and coordination), social media, and global mobility, provide; enabling these hostile networks to exploit the limitations of sovereign states to effectively counter them and by doing so further undermining the legitimacy of states.

These trends suggest that the global System will develop towards a global network of communities; such a global 'network of networks' can better ensure that populations, societies and communities can exploit economies of scale and scope that present themselves, and that (further) contribute to the fulfillment of their basic requirements.

I argue that this could ultimately be accomplished by the next finite-time singularity dynamic (1945-..., assuming that sufficient free energy is produced), through a number of successive systemic wars that result in the (step by step) dismantling of state-structures and the simultaneously empowerment of networks of communities to ensure optimal fulfillment of basic requirements and survival of populations.

323 The European Union – the European order – is 'stuck in the middle' and the challenges it is confronted with could result in 'flickering'.

KEY WORDS *European Union, EU, Stuck in the middle, Challenges, Re-nationalization, Integration, Fragmentation, Collapse, Brexit, Unstable control parameter, Flickering, Fifth systemic war, 2020.*

The current phase of development of the European Union (EU) can be best described as 'stuck in the middle': State-structures are weakened as a consequence of the partial transfer of certain responsibilities and authority to the EU, while at the same time the EU is not yet fully crystallized, and lacks integrative power to do what it is supposed to do. This stuck in the middle condition makes the EU as well as its member-states vulnerable.

Given the external challenges Europe has to confront (a more assertive Russia, a more reluctant United States, wars in the Middle East, disunity within the EU, economic crisis, etc.), and the fact that its populations are becoming increasingly skeptical if, and to what degree, the EU can contribute to the fulfillment of their basic requirements, this is a critical phase that threatens the EU's viability. A reason for the United Kingdom (Britain) to leave the EU, and 'renationalize' (Brexit).

The question now is how these developments will play out. A number of scenarios can be identified, including:

1) Europe's integrative structures become more effective in time to counter and deal with internal and external threats, avoiding (further) re-nationalization, fragmentation, and collapse.

2) European states re-nationalize, with the risk that the security dilemma is re-activated in Europe.

3) European integrative structures partially re-nationalize and collapse, and are eventually replaced by European or global network structures that are better able to balance centralized and decentralized' requirements of populations and societies in Europe (EU 2.0).
I consider the third scenario the most likely. The question is if a fifth systemic war in Europe, or as part of a global systemic war, is necessary to achieve this unavoidable result (given the increasing connectivity of the System).

The phenomenon when a system because of an unstable control parameter temporarily falls back into a previous stability domain, is also referred to as 'flickering'. Flickering is also observed in ecosystems and in our climate system.

In case of scenario 3 – with connectivity being the unstable control parameter – there also is (at least to a degree) flickering. In case of scenario 3, the EU initially (partially) collapses as a consequence of inadequate integrative structures, but, as a matter of time, is through further connectivity growth pushed back in a (more or less the same) stability domain, implying more – and 'better' – integration. Flickering in this case can be considered a process of optimization and fine-tuning.

How this process of flickering – a return to super-imposed (and possibly optimized) integrative structures – unfolds, depends on the amounts of free energy (tensions) the flickering process in- and outside Europe results in. If the security dilemma is (partially) reactivated in Europe, this will not be without consequences, and impact on the process of flickering itself.

If – as I assume is the case – the global System becomes critical around 2020 - this also impacts on the flickering process, and a fifth systemic war could contribute to the further (re-)integration of Europe.

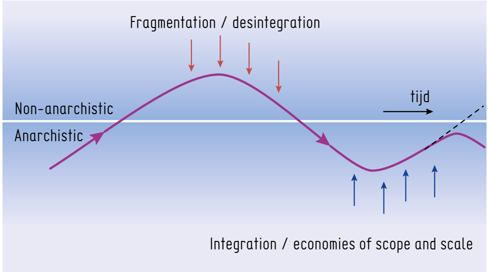


Figure 133
This figure shows how a system (for example the European Union) 'flickers' between a anarchistic and non-anarchistic stability domain.

324 Two mechanisms shaped the sizes and size-distribution of states in the anarchistic System.

KEY WORDS *Sizes of states, Size distribution of states, Bottom-up mechanism, Top down mechanism, second law of thermodynamics, Singularity dynamic, Performance, Evolvability, Interaction between mechanism, Fractal structures, Basic requirements, Optimal condition, Collapse.*

Two interacting mechanisms determined and shaped the sizes and size distribution of states in the anarchistic System, consistent with the requirements of the second law of thermodynamics; I refer to these mechanisms respectively as a 'bottom up' and a 'top down' mechanism.

1) *Bottom up*. The bottom-up mechanism concerns a mechanism that works at the level of states and their populations. Two forces compete at this level: a force pushing for increased size of the state to exploit more economies of scale and scope, to fulfill basic requirements, and a force that put limits to expansion, because of the increasing challenges that must be confronted to ensure adequate integration, in case of a larger state. There is an optimum, of course. Finding and maintaining this optimum is a dynamic process, and depends on a number of factors and conditions, for example the cultural diversity of the state, etc. This process is still unfolding in Europe, at the EU-level (the level of the super-imposed non-anarchistic hierarchy) (1).

2) *Top down*. The top-down mechanism concerns a mechanism that works at the level of the system. The anarchistic System consists of 'independent' states (units) that produce free energy (tensions) because of the intrinsic incompatibility between (increasing) connectivity and security in anarchist systems. The second law of thermodynamics applies to the free energy (tensions) that is produced in the System. The second law of thermodynamics puts free energy (tensions) to work to implement upgraded orders that allow for lower energy states in the System. In the anarchistic System, tensions are put to work through systemic wars to implement (upgraded) international orders. During the 1495-1945 period, the second law of thermodynamics produced a finite-time singularity dynamic in the System, accompanied by four accel-

erating cycles. This was a highly optimized dynamic, ensuring an optimal balance between the performance of the System (its ability to fulfill the basic requirements of uneven states in the anarchistic System during relatively stable periods), and its evolvability (its ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars.

The second law of thermodynamics ensured that the production of tensions during relatively stable periods was minimized, and that the deployment of tensions (destructive energy) during systemic wars was optimized. The finite-time singularity was (and is) about the optimized production and distribution of energy.

As is the case in other natural and physical systems, production and distribution of energy is optimized through fractal processes and structures. Fractal structures are a manifestation of the second law of thermodynamics. This explains why systemic wars consist of fractal activities, that carved out fractal structures (fractal state structures) in the anarchistic System. The size-distribution can be best described with a power-law. The fractality of the System contributed to its structural stability.

Interaction between mechanisms. The performance of states, is determined by their ability to fulfill the basic requirements of their populations; the state's size is an important factor. Over time states and their populations, became increasingly dependent on each other – and for that reason on functioning international orders – to ensure the fulfillment of their basic requirements, including their mutual security.

During the unfolding of the finite-time singularity dynamic (1495-1945), both mechanisms – both concerned with the fulfillment of basic requirements and survival of states – increasingly interacted. The interaction between both mechanisms determined the sizes of states in the System (and thus the eventual number of states in Europe), and their (fractal) size-distribution. The anarchistic System (in Europe) reached its optimal 'condition' during the fourth international order (1981-1939) shortly before its collapse in 1939.

19 EARLY WARNING SIGNALS (EWS), PREDICTION, AND FUTURE DEVELOPMENTS

325 **Due to the short lead-time between significant changes in the power flux and alliance dynamics in the System, and the actual outbreak of (systemic) war, these indicators are of limited practical use as early warning signals.**

KEY WORDS *Power flux, Alliance dynamics, Early warning signals (EWS).*

Two indicators can be introduced that are closely related to war activity of the System: the power flux and alliance dynamics. For definitions of these terms see part VI.

To quantify both indicators I make use of the Correlates of War (COW) dataset, a more detailed data source than Levy's dataset (25), (38), (59). However, data in the COW-dataset is only available starting in 1816, following the second systemic war (the French Revolutionary and Napoleonic Wars, 1792-1815).

The question is if these two indicators could be of practical use as early warning signals regarding war activity of the System. Analysis shows that this is not the case: significant changes in both measures only occur very shortly before the outbreak of war; their practical use as early warning signals is limited.

1 *Power flux*

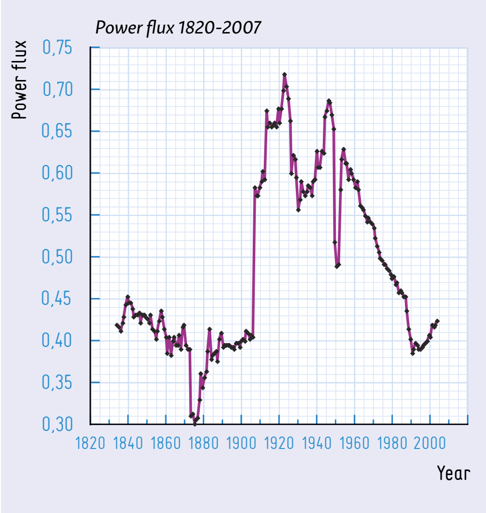
In the contingent domain, states transform tensions into destructive energy; destructive energy is deployed by states during wars.

The *Composite Index of National Capability* (CINC) is a statistical measure of national power (59). It uses an average percentage of world totals in six different components. The components represent demographic, economic, and military strengths. The CINC-index measures 'hard' power, but does not include soft power, and for that reason may not represent total national power.

The figure below shows the development of the CINC-indices of Great Powers in the System over time (starting in 1816).

The figure below shows the sum of the CINC-indices of Great Powers in the System: what I call 'power flux' of the System. The power flux indicates how much the relative contribution of Great Powers to the total available hard power in the System fluctuates over time. The power flux does not show significant changes until very shortly before the actual outbreak of (systemic) wars, and is for that reason not a practical early warning signal. Sudden (irregular) 'jumps' in this dynamic must not be attributed to developments in the System, but to the fact that at a certain point states (like the United States in 1898) acquire Great Power status, and as a consequence 'their' CINC is

Figure 134
This figure depicts the total power flux measured by the sum of the CINC-indices of Great Powers in the System (multiplied by 10). Sudden changes in the power flux cannot be attributed to the war dynamics of the System, but rather to states that acquired or lost their Great Power status. This is for example the case in 1898, when the United States acquired Great Power status. Because of the short 'lead-time' of significant changes in the power flux before systemic wars, the power flux is not a useful indicator for the upcoming war dynamics of the System.



2 *Alliance dynamics*

I have 'calculated' the – what I call – 'alliance dynamics' of the System, by determining how many alliances were formed or ended between Great Powers on a yearly basis during the period 1816 - 2007 (25).

I consider alliance dynamics another indicator of the System's contingent dynamics. Alliance dynamics intensify shortly before the outbreak of systemic wars, and somewhat precede changes in the power flux; it seems that states initially respond to increased levels of tensions and insecurity by forming alliances.

Alliance dynamics show how states connect in the System and how, throughinteracting self-fulfilling prophecies, issues and tensions crystalize in the System.

The power flux and alliance dynamics are responses to issues and tensions in the System, but they themselves increasingly become issues and tensions as well. The power flux of the System and alliance dynamics are (highly) synchronized with war activity in the System; because of the short lead-time between significant changes in their values and the actual outbreak of wars, they are of limited practical use as early warning signals.

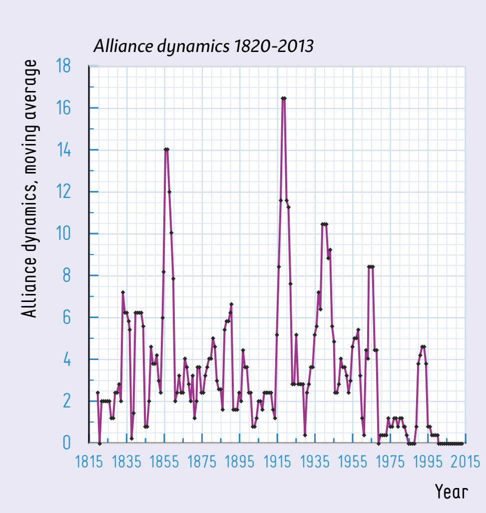


Figure 135
This figure shows the alliance dynamics of the System as the moving average of the sum of alliances started or ended by Great Powers in the System in increments of five years during the period 1820-2013 (25).

326 How to escape the self-organized war trap we are an integral part of?

KEY WORDS *Prevention, War trap, Intrinsic incompatibility, Connectivity, Security, Anarchy, Free energy.*

Can the war trap (the second finite-time singularity dynamic, 1945-…) we collectively produce by our interactions in the anarchistic System be 'broken', now we are aware that our urge to survive, connectivity growth (closely related to population growth) and physical laws produce this self-organized war trap?

This research shows that a solution must address – 'solve' – the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems. Three basic courses of action are open to escape the war trap (at least theoretically): (1) preventing the production of free energy (tensions) in the System, (2) find alternative means (other than (systemic) war) to put the free energy to work to implement upgraded orders, and (3) a combination of (1) and (2), assuming our efforts to avoid the production of free energy will not be (completely) successful.

In below table I elaborate on these three theoretical courses of action. However, to make a realistic assessment of our capabilities to address these (fundamental) issues, the current worrisome condition of System cannot be ignored.

The current relatively stable period (international order, 1945-…) is now in its high-connectivity regime, when typically, tensions are produced at high rates, but instead of being released increasingly 'stored' in the System; the accumulating tensions crystalize in vulnerable issue clusters that will eventually become connected, and cause the System to become critical: The System is now charging for a next critical period and systemic war.

This condition of the System is characterized by high tension levels, and high-levels of distrust; but trust is what is now needed.

	Course of action	Action	Evaluation
Avoiding the war trap (= the second finite-time singularity dynamic accompanied by accelerating cycles, 1945-...)			
1	Prevent the production of free energy (tensions), by neutralizing the intrinsic incompatibility between connectivity (growth) and security in anarchistic systems	Prevent connectivity growth	Population growth is the (main) driver of connectivity growth. Not realistic
		Abolish anarchy by imposing global communities that 'neutralize' the state (the security dilemma)	Anarchy in (parts of) the core was eventually abolished by a series of accelerating systemic wars, and a phase transition (the fourth systemic war). **Not realistic at this stage** (also taking the current condition of the System into consideration)
2	Develop alternative 'mechanisms' than war to release free energy (tensions), and design and implement upgraded orders	Impose global communities that neutralize the security dilemma (states)	States – one of the main features (integral components) of the anarchistic System – can be neutralized by imposing global communities, that interact on the basis of a fundamentally different rule-sets. **I consider this approach (at this stage) not realistic**.
		Implement upgraded orders through negotiations (other than systemic war).	The current five permanent members of the Security Council of the United Nations must abandon or more fairly share their privileges. Britain and France must abandon their permanent seats in the Security Council of the United Nations, and make place for other states that have acquired more central positions in the System, or 'combine' their separate permanent memberships in the Security Council with a single European seat. This is problematic: The United Nations is designed to protect the status quo, it is itself the representation of. Although this is problematic: given what is at stake - a systemic war (a Third World War), **this is worthwhile the effort.**

Table 106 *This table gives an overview of (two) basic courses of action to prevent a next war trap: (1) prevention of free energy production, and/or (2) developing alternative mechanisms to design and implement upgraded orders. Both courses of action address the intrinsic incompatibility of (increasing) connectivity and security in anarchistic systems. (Also) taken the current stage of development of the current international order – the order is in a high-connectivity regime, and 'charging' – our options are limited.*

A related question to these issues is what the function of this study as this stage can be: Will and can this study (at this stage) be used to prevent a next systemic war, or will it instead be used by states to 'better' prepare for a next systemic war they consider (at this stage) unavoidable, also being aware (as this study shows), that the next systemic war (as was the case with its predecessors) will define the next international order, and their place (position) within it? Let's try to make it work.

327 Integration and expansion of the System were coevolving and mutually reinforcing dynamics.

KEY WORDS *Integration, Expansion, Reinforcing dynamics, Synchronization.*

Analysis of war data concerning the first finite-time singularity dynamic of the System, accompanied by four accelerating cycles that unfolded during the 1495-1945 period, shows that the process of integration in the core of the System (Europe) and its simultaneous expansion into non-core territories (outside Europe) were closely related dynamics. The pace of integration and expansion of the System increased with the same rate, as figure 22 shows. This is no coincidence; the pace of both dynamics is determined by the same increasing connectivity in the System, and both dynamics reinforced each other.

The implementation of successive upgraded orders in the core of the System (Europe) was also powered by the expansion of European states outside Europe, and vice versa; expansion of states made additional resources available, but also produced additional rivalries and additional free energy in and (later) outside of the core of the System.

328 State-structures in Europe and difficulties in designing and implementing integrative structures in the European Union hinder the development and exploitation of new synergies offered by the new level of SIE.

KEY WORDS *States, Integration, Fragmentation, Synergies, SIE.*

In 1939, the anarchistic System, a finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), reached the critical connectivity threshold and produced infinite amounts of free energy (tensions). This forced the System to make a transition to a system with a non-anarchistic configuration.

As a consequence of the phase transition, war and state-structures – closely related phenomena – had become obsolete: war – energy releases – were not necessary anymore (the production of free energy had stopped), and the state – fighting these wars and ensuring security to their populations – had fulfilled their primary task.

Now security was ensured, the neutralization of rivalries between states opened up new opportunities for states and populations to develop and exploit enhanced synergistic economies of scale and scope in the new non-anarchistic system.

Certain properties of European states (in)directly related to their now obsolete primary task, however, hinder(ed) the exploitation of synergies and need(ed) to be dismantled. The fact that a next level of SIE had been reached also meant (and means) that this new level must develop integrative structures to ensure the optimized utilization of new synergies and maintain an internal balance. Furthermore, the new level of SIE also had (and has) to ensure that external challenges and threats could (and can) be adequately dealt with. This is a process in which forces for integration and fragmentation compete; during their formation, states also had to deal with these forces.

Presently the new level, the European Union, is struggling with organizing itself and accomplishing its primary tasks, fueling doubts about its viability.

20 IMPLICATIONS

329 The accuracy of current historical research methods and results is seriously overrated.

KEY WORDS *Methods, Historical research, Deterministic domain, Contingent domain. Interface, Security dilemma, Interacting self-fulfilling prophecies, Contingent latitude, Chaotic war dynamics, Intrinsic unpredictability, Sensitivity for initial conditions.*

For a number of reasons historical research methods and results are not accurate, and in fact are mostly not more than unfounded assumptions. These reasons include:

1 ***The existence of the deterministic domain – and 'impact' of deterministic laws – is not taken into account***
This study shows (proofs) that physical laws, including the second law of thermodynamics, also apply to the System; and that (as a consequence) the System to a high degree is deterministic. The finite-time singularity dynamic, systemic wars, and non-systemic wars are deterministic in nature. The timing, duration, and the amount of destructive energy that is put to work during systemic wars, for example, are determined by the 'deterministic domain'. It is not possible to make sense of events, (systemic) wars and historical processes when the deterministic domain and its impact on the System are ignored. Until now, we were not aware of the existence of such a domain. As a consequence – in efforts to make sense of (historical) events and processes – we (often) constructed artificial causalities. The Second World War – a Second World War (the fourth systemic war, 1939-1945) – in fact, was already un unavoidable systemic energy release, that was 'programmed' in the finite-time singularity dynamic at its inception, in 1945.

2 ***The workings of the interface between the deterministic and contingent domains of the System are not taken into account***
This study also reveals that it is possible to distinguish a deterministic and contingent domain in the System; events, incidents, processes, (war) dynamics, etc. we experience, are a product of the deterministic 'domain' (that include physical laws that apply to the System, like the second law of thermodynamics) and the contingent domain; contingent events, etc. that do not have to obey physical laws. Both domains interact, and must – so to say – synchronize. An 'interface' is responsible for the synchronization of both domains: The interface ensures that 'contingent' dynamics meet deterministic demands. I assume that the synchronization of both domains is accomplished through two mechanisms in particular: the security dilemma and interacting self-fulfilling prophecies between states. Both mechanisms ensure that the contingent domain meets the requirements of the deterministic domain,

that we – for example – put 'exactly' the right amounts of destructive energy to work as is prescribed by the second law of thermodynamics. Both mechanisms ensure that we can make sense of our (inter)actions without even recognizing that we obey physical laws that allow us no other choice.

The workings of the interface – of both mechanisms – must be understood. Both mechanisms determine what issues become crystallization points – attractors – for tensions, and shape future events in the contingent domain of the System.

3 ***The contingent latitude is unknown***

In this study I explained that the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), constitutes a path-dependent dynamic that locked-in on increasingly comprehensive international orders, and an unavoidable dual-phase transition. In fact, the singularity dynamic increasingly became a war trap, and the interactions between states and between states and successive international orders, forced states to produce and deploy increasing amounts of destructive energy. This highly deterministic dynamic, increasingly restricted the 'freedom of action' of states and populations in the System. I define the latitude that is left for contingency in the System, as 'contingent latitude'. Over time the contingent latitude of the System decreased. As already mentioned, the deterministic domain determined the timing, duration and the amount of destructive energy that had to be deployed during the Second World War. What social issues this war would be fought for, who would become the 'cast' of this war, did not concern the deterministic domain, and was left to the contingent domain: as long as deterministic requirements were met, the deterministic domain 'did not care'. Cast and social issues constitute the contingent latitude of the System.

To make sense of events and historical processes, the contingent latitude of the System must be taken into account.

4 ***The intrinsic unpredictability of chaotic war dynamics is not recognized***

Normally, except for two exceptional periods (1657-1763 and 1953-1989), non-systemic wars are chaotic in nature. The fact that these dynamics are chaotic means that these wars are intrinsically unpredictable (at least regarding their size and intensity/severity), because of the high sensitivity of these dynamics for the initial conditions of the System. Because of this high sensitivity, it is also problematic to determine the exact relationship between causes and effects of non-systemic wars in hindsight, and to derive lessons learnt and sensible policy advice from these wars.

330 Cycles are the building blocks of the singularity dynamic and must be used as units of analysis.

KEY WORDS *Cycles, Unit of analysis.*

Analysis on a century-by-century basis, as typically performed by historians, does not make much sense.

Sensible analysis not only requires the identification of the singularity dynamic and the four accelerating cycles it produced, but also recognition of the fact that the System produced (and produces) two categories of fundamentally different types of wars, namely systemic and non-systemic wars as already explained in part I. Systemic wars are not scaled-up versions of non-systemic wars, but are manifestations of critical points that perform system-wide functions, etc.

331 Current historical research methodology lacks a coherent framework and scientific research methods, and produces unreliable results that misinform decision makers.

KEY WORDS *Chaotic war dynamics, Framework, Shortcomings, Sensitivity for initial conditions, Intrinsic Unpredictability.*

Chaotic non-systemic wars are highly sensitive for initial conditions, and are intrinsically unpredictable as a consequence. Although chaotic war dynamics are deterministic in nature, their actual development and dynamics – how they play out and what their sizes and intensities will be – are highly contingent, conditional on (very) specific circumstances. This characteristic of chaotic war dynamics has a number of implications for our ability to reconstruct and understand historic events and for the usability of historical experience to inform strategies and policies. In this section I discuss two limitations.

1 ***Historical events cannot be accurately reconstructed***

Historians and social scientists reconstruct events in efforts to identify causes and effects and explanations for what happened, and why. Historians, not aware of the deterministic nature of the System, until now focused all their efforts exclusively on highly contingent events. The very serious shortcomings of these methods are now evident: war dynamics and the development of the System can only be explained and understood if the deterministic laws that determine and shape these dynamics are taken into consideration.

During non-systemic war dynamics, there is an additional complication. Size, severity, and duration of non-systemic wars are highly sensitive to the initial conditions of the System around the time of outbreak of these wars, in case the System is governed by at least three degrees of freedom. The question is if the initial conditions that define the main characteristics of chaotic non-systemic war dynamics can be identified and reconstructed. Historians can, at best, construct narratives that describe events that preceded them; attributing specific causes to effects and vice versa is problematic. The fact that historians can produce a multitude of competing narratives for very specific events and wars is evidence of their inability to explain what actually happened.

2 ***The sizes, severities, and durations of non-systemic wars are intrinsically unpredictable and cannot be forecasted***

This limitation is closely related to the first. Despite their determinist nature, chaotic war dynamics are unique events, and it is problematic to draw lessons from particular non-systemic wars and apply them to different situations. The following examples illustrate when so-called lessons learnt (based on past events) were applied and did not – could not, this study shows – work out. Policy makers, politicians, and strategists alike were wary of the United States becoming bogged down in Iraq in 1990-1991 (the Gulf War, 1990-1991, nr. 124), because this is what happened (to their surprise) during the war in Vietnam (1965-1973). To their great relief and surprise, this (bogging down in Iraq, 1990-1991) was however not the case. The success of this Iraq war was then attributed to superior doctrines, technology, and decision-making, and to the application of the right lessons learnt from previous wars. It is, however, more realistic to conclude that the Vietnam War did not provide any valuable guidance, at least as far as the size, severity, and duration, of the Gulf War were concerned. The Iraq War (2003-2011, nr. 130) makes the point for the intrinsic unpredictability of non-systemic war dynamics. The First Iraq War (1990-1991) did not (and, I argue, could not) provide any sensible guidelines for the conduct of the Iraq War; a war (besides the War of Afghanistan, 2001-214, nr. 129) that actually became the quagmire the United States hoped to prevent in the first place.

The success of the Gulf War (1990-1991) was attributed to the application of a doctrine that advocated the application of 'overwhelming power' (named the 'Powell doctrine'); however, as the Iraq War (2003- 2014) shows, deployment of overwhelming power in the 'Shock and Awe' campaign at the start and during the Second Iraq War did not have the expected effect. I argue that the unpredictability of the size, severity, and duration of non-systemic wars has to be attributed to their chaotic and intrinsically unpredictable nature, besides that historical analysis and policy evaluations often also leave much to be desired.

There are lessons to be learned regarding non-systemic wars; the fact that they are intrinsically unpredictable is the most important one. Non-systemic wars resemble the weather, another chaotic and difficult to predict dynamic (however, this study provides us with a 'climate science' for the dynamics and development of the System).

332 The unfolding of a finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) and the chaotic properties of non-systemic war dynamics, show that the System was (and still is) deterministic in nature.

KEY WORDS *Singularity dynamic, Deterministic domain, Contingent domain, Free will.*

The finite-time singularity dynamic and how it unfolded during the 1495-1945 period is a function of the connectivity of the System and the intensity of interactions between states.

In fact, the initial conditions of the System at its inception around 1495 already defined the singularity dynamic in detail, including the timing of when the System would (four times) reach criticality during the 1495-1945 period. This means that the timing of systemic wars, including the ultimate phase transition of the System when it reached in 1939 the critical connectivity threshold, is mere an application of certain physical laws and were (so to say) already 'programmed' into the System at its inception.

Chaotic and periodic dynamics are also deterministic in nature. The fact that the System is deterministic is difficult to comprehend and, probably for historians and social scientists, difficult to accept. We were and are not masters of our destiny. On the contrary, our interactions were and are to a very high degree determined and shaped by an 'underlying' deterministic domain and dynamics that we until now did not know existed.

This study shows that analytically two types of dynamics must be distinguished: the (underlying) dynamics *of* the System that are deterministic in nature, and the dynamics *on* this underlying network (i.e., events playing out *on* this network) that are contingent. For example, this study shows that the fourth systemic war (the Second World War, 1939-1945)) would have been produced anyway by the System, independent of its (exact) contingent dynamics that unfolded on the network of the System preceding this war. Wars do not originate in the contingent domain but rather in the underlying deterministic domain that, until now, we were not aware existed. Causes of war cannot be found in contingent events and incidents. If the protagonists we now hold responsible for the outbreak of the Second World War (1939-1945) had not existed, other events and protagonists would have taken their place and also produced a systemic war, consistent with the requirements of the second law of thermodynamics. This is indeed difficult to comprehend, and perhaps to accept. This study shows that what we define and experience as 'free will' - deliberate choices - is in fact not so 'free' as we think: The dynamics of the System to a high degree obey deterministic laws; that can never be ignored. On the contrary, in fact our 'free' will – and the decisions the System allows us to make – are highly determined and shaped. The new insights that I present in this study and the revelation of the deterministic domain and dynamics along with their consequences make it possible and necessary to evaluate past historical and social research, correct fundamental misconceptions, and use them to our collective advantage to more effectively prevent and control war (dynamics).

The finite-time singularity dynamic, including the systemic wars that are an integral part of this dynamic, is a self-organized macro-dynamic caused by a multitude of (micro) interactions between the components of the System (states and their societies). Now at least we are aware of this destructive 'war trap' that controls and determines our (daily) interactions and the development of our System. An alternative for systemic wars must be found to reorganize the anarchistic Systems and ensure the balanced fulfillment of basic requirements by states.

333 The fourth systemic war (the Second World War, 1939-1945) was, in fact, the first global war.

KEY WORDS *Fourth systemic war, First global order, Linkage.*

Although non-core Great Powers, Japan and the United States, were involved in the third systemic war (the First World War, 1914-1918), they were not integral components of this systemic war. Criticality of the System was restricted to its core (Europe). In December 1941 the System became critical at a global scale for the first time, when the critical core of the System (Europe) became connected to issues and wars in Asia. This linkage was accomplished through the German declaration of war upon the United States on 11 December, out of solidarity with Japan's attack on the United States (Pearl Harbor, 7 December 1941).

334 Until now, historical research was restricted to the contingent domain. It was incomplete and led to misguided conclusions and policy advice.

KEY WORDS *Deterministic domain, Contingent domain, Artificial causalities.*

Until now historical research only concerns events and developments in the contingent domain of the System; there is no awareness of the existence of a deterministic domain, and the fact that the deterministic domain determines key properties of contingent dynamics. Making sense out of contingent events without knowledge of the existence of the deterministic domain and its impact, is impossible and leads to false explanations and the construction of artificial causalities.

335 Our attempts to change the System 'from within', through its existing structures and institutions are doomed to fail.

KEY WORDS *Change from within, International orders, Dominant states, Privileges, Fourth systemic war, United Nations, Monopoly, Status quo.*

International orders the anarchistic System produced (1495 - present) are the outcomes of systemic wars. During systemic wars, states – making use of the critical properties of systems during criticality (enabling system-wide communication, coordination and planning) – collectively design and implement upgraded orders, that allow for new relatively stable periods.

During systemic wars, dominant states have more influential positions to shape and determine the arrangements that underpin the upgraded orders they 'collectively' design and implement. More dominant states use their more powerful positions, to make sure that their (specific) interests are (especially) taken care of, by including privileges in the accompanying arrangements.

These privileges make that more dominant states have special (additional) interests in the 'new' upgraded order, and for that reason in maintaining its status quo. The privileges and special interests of more powerful states – the powerful-become-more-powerful effect – contributed to the increasing structural stability of successive international orders. However, these privileges also carried the seeds in them of the eventual (and unavoidable) collapse of the international orders they underpinned.

The current – fifth – international order (1945 - present) is no exception on this typical dynamic. The current international order is the outcome of the fourth systemic war (the Second World War, 1939-1945). The fourth systemic war constituted a dual-phase transition, and resulted in the simultaneous implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a first global order at a global scale of the System.

In the current order, a select number of Great Powers (the United States, the Soviet Union/Russia, China, Great Britain, and France) enjoy a number of privileges that they have designed and implemented themselves. The fact that these powerful states have assigned privileges to themselves contributes to the structural stability of the System: The most powerful states have the most to lose by changes in the status quo.

These privileges include a permanent seat in the Security Council of the United Nations, veto rights, and a monopoly on the legal possession of nuclear weapons.

Particularly the fact that Great Britain and France still enjoy such privileges, and numerous by now more powerful states do not, is illustrative for the outdatedness of the current order; but also for its intrinsic inability of the international order to adapt its structure (including privileges) 'from within', by peaceful means. It is not to be expected that these privileged states will voluntarily abandon their privileges and downgrade themselves in the formal status hierarchy of Great Powers; for them an upgraded order will have less to offer.

336 A number of scientific and methodological shortcomings prevented historians and social scientist form identifying the deterministic nature of the dynamics of the System.

KEY WORDS *Research, Shortcomings, Deterministic laws, deterministic domain, Contingent domain, Chaotic war dynamics, Exceptional period, Low-connectivity regime, High-connectivity regime.*

These shortcomings include the inability to identify/recognize:

1) That the second law of thermodynamics and a number of other deterministic laws and principles apply to the dynamics of the System, and resulted in a finite-time singularity dynamic accompanied by four accelerating cycles during the 1495-1945 period, and the start of a second finite-time singularity in 1945, that is now unfolding.

2) The fact that cycles that accompany the singularity dynamics are the only sensible units of analysis to (be able to) make sense of the System's dynamics and to expose its properties.

3) The interaction between deterministic and contingent domains in the System.

4) The fundamental difference between systemic and non-systemic wars.

5) The default chaotic nature of non-systemic wars.

6) The temporary disruption of non-systemic war dynamics during the first exceptional period (1657-1763), resulting in a series of extreme non-systemic wars, and during the second exceptional period (1953-1989), resulting in a series of subdued non-systemic wars.

7) That relatively stable periods (international orders) have typical life cycles that include low- and high-connectivity regimes that are separated by tipping points.

337 The relationship between the First (1914-1918) and Second World War (1939-1945) is deterministic in nature.

KEY WORDS *First Word War, Second World War, French Revolutionary and Napoleonic Wars, relationships, Contingent domain, Deterministic domain.*

Historians and social scientists failed to identify the deterministic nature of the System; the fact that a number of deterministic laws shape and determine the dynamics and development of the System.

It is possible to distinguish a deterministic and a contingent domain in the

System. The deterministic domain determines the latitude of the contingent domain, the latitude for contingent dynamics of the System. Contingent dynamics are 'allowed', as long as they do not conflict with deterministic laws and their requirements.

In order to make sense out of the (contingent) dynamics of the System, historians constructed various 'theories' and causalities, suggesting that these causalities were responsible for the events and processes historians identified. Often these causalities and explanations were (and are) incomplete and misguided.

Historians for example identified certain contingent relationships between the First and Second World Wars (respectively the third (1914-1918) and fourth (1939-1945) systemic wars, the finite-time singularity produced (1495-1945)), for the simple reason that they could in this case (re)construct certain causalities in the contingent domain of the System.

Because of these (contingent) causalities some historians suggest(ed) that the Second World War was mere a continuation of the First. This observation is (partially) correct, but for the wrong reasons: both wars are connected, because they are both integral components of the four accelerating cycles that constitute the first finite-time singularity dynamic which was accompanied by four accelerating cycles (1495-1945). The finite-time singularity dynamic accompanied by four accelerating cycles reveals, that the second systemic war (the French Revolutionary and Napoleonic Wars, 1792-1815) is as connected to the First World War (1914-1918), as is the First World War to its successor the Second World War (1939-1945).

The connectedness of (the relationship between) systemic wars lies in the highly deterministic finite-time singularity dynamic accompanied by four accelerating cycles, and the deterministic laws that produced the singularity dynamic. Contingent causalities are what they are: contingent, and do not – cannot – explain the 'emergence' of the Second World War (1939-1945), shortly after the First (1914-1918).

338 Napoleon, Hitler, and Churchill, all great men of history, were mere effective manipulators of tensions and events in the contingent domain of the System.

KEY WORDS *Great Men, Deterministic domain, Contingent domain, Contingent latitude.*

Upgraded orders in the anarchistic System are implemented through systemic wars. Systemic wars are manifestations of criticality in the deterministic domain of the System, and are highly deterministic in nature. The timing, duration and intensities/severities of systemic wars are deterministic properties. Deterministic laws determine how much contingent latitude there is; latitude for contingent dynamics.

The reasons these (and other) wars are fought, what social issues and ideologies are 'used' to shape events, and what key players made decisions within the 'contingent latitude', are highly contingent variables. The 'versions' of wars we know are the highly contingent versions that actually unfolded in the contingent domain.

If the contingent key players who were able to dominate the stage at those moments in time had not emerged, others would have taken their places, and would have produced different outcomes, but only in the contingent domain of the System. The deterministic domain is indifferent to the nature of contingent dynamics, as long as its (deterministic) demands are met.

Napoleon only started and shaped a cascade of contingent dynamics that were produced by deterministic dynamics, by effectively using interacting self-fulfilling prophecies in the contingent domain for his 'own' ambitions and purposes; by doing so he produced the French Revolutionary and Napoleonic Wars (1792-1815). This was but one out of many versions that were available in the contingent domain.

339 Our freedom of choice is much more restricted than we are aware of and is often not more than an illusion.

KEY WORDS *Freedom of choice, Free will, Illusion, Singularity dynamic, Contingent domain, Contingent latitude, second law of thermodynamics, Security dilemma, Interacting self-fulfilling prophecies.*

States, through a multitude of interactions, in efforts to fulfill their populations' growing basic requirements, produced increasing amounts of free energy in the anarchistic System; deterministic laws applied (and still apply) to the free energy (tensions) states produce(d).

These deterministic laws and mechanisms 'transformed' the free energy (tensions) that the System produced into a self-organized accelerating finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945). The highly deterministic finite-time singularity dynamic set the stage for contingent dynamics; as far as the deterministic laws allowed for 'contingent latitude'.

The acceleration of the singularity dynamic caused by the System's increasing connectivity forced free energy releases wars (systemic wars in the contingent domain) on the System at an accelerating rate; the timing, duration, and the amount of free energy that had to be put to work during successive systemic wars were imposed by the second law of thermodynamics and were not a matter of choice in the contingent domain.

The security dilemma and interacting self-fulfilling prophecies between states ensured (and still ensure) that contingent dynamics and deterministic requirements were always synchronized. The security dilemma and interacting self-fulfilling prophecies 'shaped' the crystallization of free energy into issues and tensions in the contingent domain of the System, and ensured that these issues and tensions were 'within' the contingent latitude allowed by the deterministic domain.

The security dilemma and interacting self-fulfilling prophecies are powerful 'shapers', and ensure that the expectations from states (and their populations) in anarchistic systems (for example regarding threats from other states in the System) are always met. This 'dynamic' gives the false illusion to states, their decision-makers and populations, that the System responds to their 'free choices'; however, that is a misleading interpretation: both mechanisms ensure that in anarchistic systems you get what you expect. Anarchistic systems do seldom disappoint.

Through the self-organized finite-time singularity dynamic, accompanied by four accelerating cycles, that developed and unfolded in the System during the 1495-1945 period, states and populations unintentionally and unknowingly produced a 'context' they had to obey and respond to, to ensure compliance with the second law of thermodynamics.

Our free will is much more limited than we think and want to believe.

340 Historical research and International Relations theory require a paradigm shift to be of any use and to escape the war trap that we collectively produce(d).

KEY WORDS *Historical research, International Relations theory, IR-theory, Paradigm shift.*

To make sense of historical processes and dynamics in the System, and in the current international order, it must be recognized that the System is highly deterministic and that its contingent dynamics and development (as far as there is latitude) are shaped and determined by deterministic laws and mechanisms.

This study shows that there is not as much contingency – and free-choice – as is assumed and that the causalities historians and social scientists identify are often incomplete and artificial fabrications. History and International Relations theory (IR-theory) are incomplete pseudo sciences that ignore the most fundamental properties of the System, including the fact that deterministic properties determine the latitude and certain properties of dynamics in the contingent domain of the System.

Historical processes and the development of the current international order (System) can only be understood if historical science and IR-theory fundamentally adjust and redefine their paradigms and take the deterministic domain and the workings of the interface between the deterministic and contingent domains into account. Prevailing paradigms are incomplete, based on misguided assumptions, and, in all respects, deficient for making sense of historical processes and future developments (see also: (65), (74)).

341 The chaotic nature of non-systemic war dynamics makes the timing, duration, size, and severity of non-systemic wars highly sensitive for the initial conditions of the System (the conditions at the time of the emergence of non-systemic wars). Non-systemic wars are intrinsically unpredictable and for that reason also difficult to understand in hindsight.

KEY WORDS *Chaotic conditions, Sensitivity for initial conditions, Intrinsic unpredictability, Explanation in hindsight, Cause and effect.*

In case of chaotic conditions (n, the number of degrees of freedom of the System > 2), small differences in initial conditions of the System are exponentially magnified and result in fundamentally different war dynamics; (almost) similar initial conditions produce non-systemic wars with very different properties (for example sizes and severities). As a consequence, the properties of non-systemic wars are intrinsically unpredictable.

However, these characteristics of chaotic non-systemic war dynamics, also makes it problematic to explain them (their properties) in hindsight. Given the high sensitivity of non-systemic wars to initial conditions, it is problematic to identify and attribute precise causes to the properties of non-systemic wars; relationships between causes and effects are ambivalent.

The intrinsic ambivalence complicates historical analysis and interpretation. It is impossible to reconstruct the exact initial conditions of the System before chaotic non-systemic wars, to identify (precise) causes of these wars and to explain their 'behavior. These unavoidable analytical shortcomings undermine our ability to formulate reliable policy advice, based on the analysis of previous non-systemic wars.

I argue, at best, it is possible to identify classes of scenarios that result in classes of effects.

To make my point, I now give some examples of (predictable) failures to formulate sensible policy advice, based on past experience.

Based on experience in the Vietnam War (1965-1973) the United States was reluctant to 'start' the (what would be named) Gulf War (1990-1991, nr. 124), because of fear to get create another 'quagmire'. Overwhelming force was the lesson learnt that was applied. This approach (decisive force), however, did not provide reliable lessons for the next two wars the United States started: War of Afghanistan (2001-2014, nr. 129) and the Iraq War (2003-2011, nr. 130). Also, despite numerous 'similarities', the wars in Iraq and Afghanistan did not have any predictive use for the wars in Syria (2011-...) or Libya (2011-...), beyond faulty and misguided predictions confirming the intrinsic unpredictability and ambivalence of non-systemic wars.

Because the underlying causes of the unpredictability of chaotic non-systemic wars are not recognized, the failure to make reliable predictions, is in hindsight often attributed to certain differences between wars that were believed to be similar in some key-respects. Application of this logic is, however, also misguided.

The fact that the Gulf War did not, as was feared, result in a Vietnam-like quagmire that the United States was sucked into and could not escape, but instead came to a surprisingly fast solution, was in hindsight attributed to decisive levels of force that were deployed during the Gulf War. This lesson resulted in the 'Powell doctrine'. Application of the Powell doctrine in the Iraq War (2003-2011), also referred to as 'shock and awe,' could not prevent this war from escalating and resulting in a Vietnam-like quagmire that this doctrine had previously demonstrated it could avoid.

As I proposed, at best, classes of scenarios that result in classes of effects can be identified, but must then be 'linked' to the properties of the regime (low- or high-connectivity) that applies to the non-systemic war dynamics of the System (regime).

However, while non-systemic wars are intrinsically unpredictable, systemic wars that really define international orders and relatively stable periods are highly predictable. Research methods must be developed that take these fundamental differences into account. Historical and social science needs a paradigm shift to meet scientific standards and to be of more practical use.

342 As long as its demands are met, the deterministic domain does not concern itself with contingent dynamics.

KEY WORDS *Deterministic domain, Contingent domain, Contingent dynamics, First World War, Third systemic war, Bipolar system.*

Clark observes in "*The Sleepwalkers, How Europe went to War in 1914*" that in the decennia preceding the First World War, dynamics between states ('alliance dynamics') transformed the System from a multipolar system in which a plurality of forces and interests balanced each other in a precarious equilibrium, to a bipolar system (18). "You see a bipolar Europe organized around two alliance systems ... the profiles of two armed camps are clearly visible. The polarization of Europe's geopolitical system was," according to Clark, "a crucial pre-condition for the war that broke out in 1914."

Clark further observes: "The bifurcation into two alliance blocs did not cause the war; indeed it did as much to mute as to escalate conflict in the pre-war years. Yet without the two blocks, the war could not have broken out in the way that it did. The bipolar system structured the environment in which the crucial decisions were made."

According to this study, alliance dynamics and the configurations in which they crystalize are contingent dynamics; the deterministic domain determines their latitude.

During its life span (1495-1945), the System developed different types of configurations in the contingent domain. Historians studied these configurations extensively (35) in efforts to find causal relationships between typical configurations and the behavior (dynamics) of the System.

This study shows that contingents dynamics in the System, are to a high degree determined and shaped by the deterministic domain; the deterministic domain determines the 'contingent latitude' of the System. This study also shows that contingent dynamics cannot be understood without taking the deterministic domain into consideration.

When the four cycles that accompanied the finite-time singularity dynamic (1495-1945) are used as units of analysis, there seems to be no connection between the configurations of international orders shortly before the outbreak of systemic wars, and these systemic wars.

The start time, duration, severity, and purpose of systemic wars (to establish upgraded orders) are deterministic properties of the System, consistent with the requirements of the second law of thermodynamics. Issues, ideologies, and political purposes for which systemic wars are fought, how preceding tensions crystalize in configurations, and how wars are actually fought, do not matter for the deterministic domain as long as its laws are obeyed.

343 The implementation of cooperative structures in the contingent domain of the System is not indicative for changes in the nature of humanity, but is enforced by the second law of thermodynamics.

KEY WORDS *Contingent domain, Nature of humanity, second law of thermodynamics, Cycles, Integration, Mass destruction, Interacting self-fulfilling prophecies.*

The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) is the 'product' of the tensions (free energy) that were produced by growing populations, organized in states in the anarchistic System, that strove to survive, and the second law of thermodynamics that applied to these tensions.

Given the accelerated production of free energy in the anarchistic System, the second law of thermodynamics demanded the accelerated implementation of upgraded orders to allow for lower energy states in the System. In the contingent domain of the System, the successive upgraded orders resulted in increasingly comprehensive organizational arrangements that underpinned international orders. The finite-time singularity dynamic accompanied by four accelerating cycles set in motion a ('parallel) process of cooperation and integration in the contingent domain of the System. The 'coordination' between the deterministic and contingent domains of the System was accomplished through the mechanism of 'interacting self-fulfilling prophecies'.

The increasingly comprehensive organizational arrangements that underpinned successive international orders, formed a prelude for the eventual implementation of two dedicated non-anarchistic hierarchies in Europe (the core of the System).

The increasing levels of cooperation were not, as is often suggested, the outcome of a learning process by states and their populations and societies: The second law of thermodynamics forced them on the System. The almost unbounded 'flexibility' of humanity, populations, and societies to adjust themselves through interacting self-fulfilling prophecies to the deterministic requirements of the System, ensured that the process of integration could continuously be justified and attributed to deliberate choices and acts of free will. The interacting self-fulfilling prophecies that make states and populations think they decide to go to war also make them think they decide on the implementation of cooperative structures.

Wars, as well as (the arrangements of) international orders, are 'forced' upon the System by the second law of thermodynamics to allow for a lower energy state. The details of organizational arrangements that are implemented are not relevant for the second law of thermodynamics, as long as its requirements (lower energy states) are met.

The moment in 1945 states in the European core of the System collectively switched from mass destruction to integration and cooperation was not the outcome of a 'learning process', and also does not mark a sudden step in the evolution of humanity; it is the application of a deterministic law, in combination with our (collective) urge to survive; and yet another demonstration of the unbounded flexibility of humanity to adjust itself to deterministic requirements.

344 A bipolar system is not necessarily equivalent with two degrees of freedom.

KEY WORDS *Bipolar system, Degrees of freedom.*

'Bipolarity' - a typical configuration in the System, when an alliance consists of two opposing alliances - does not imply that the number of degrees of freedom of the System is reduced to two. If this were the case, bipolarity and non-chaotic war dynamics would always go hand in hand. It is the level of intensity of rivalries, not bipolarity as such, that determines the degrees of freedom of the system.

Regarding bipolarity, Clark observes that, despite the bipolarity of the System preceding the First World War, when Europe was organized around two alliance systems (the 'Triple Alliance' between Germany, Austria, and Italy, and three connected bilateral agreements involving Britain, France, and Russia), states could not afford to ignore the interactions and positions of multiple other states. "For Russia, as for Britain this was still a world in which there was more than one potential enemy. Beneath the scaffolding of the alliances lurked older imperial rivalries" (18). Despite a 'bipolar' configuration of the System, the positions and interactions of more than two states impacted states' war decisions, implying that the degrees of freedom of the System (n) is larger than two (n > 2).

345 Unawareness of the existence and impact of the deterministic domain on the dynamics and development of the System, leads to fundamentally wrong assumptions and interpretations.

KEY WORDS *Deterministic domain, second law of thermodynamics, Contingent latitude.*

Clark's research only concerns the contingent domain of the System; Clark and other historians are not aware of the existence and decisive impact of the deterministic domain (18). This unawareness leads to false assumptions and conclusions. For example, when causalities cannot be reconstructed in the contingent domain, developments are seen as discontinuous: "Crucial to the complexity of the events of 1914 were rapid changes in the international system (...). These were not long-term historical transitions, but short-range realignments. (...) It draws our attention to the place of short-range, contingent realignments in shaping the conditions under which the crisis of 1914 unfolded" (18).

This study shows, that this is interpretation of the dynamics and development of the System is not correct; deterministic laws determine the timing of systemic wars; and systemic wars are integral components of the finite-time singularity that unfolded in the System during the 1495-1945 period. The short-range realignments Clark refers to are in fact not relevant, as long as the demands of the second law of thermodynamics are met.

Clark also refers to "some of the most interesting recent writing on the subject" in which Afflerbach and Stevenson argue that "far from being inevitable, this war was in fact 'improbable' - at least until it actually happened (18). From this it would follow that," according to Clark, "the conflict was not the consequence of a long-term deterioration, but of short-term shocks to the international system."

I argue that this suggestion is fundamentally wrong; this study reveals that a highly-deterministic dynamic shaped the contingent dynamics of the System and left not much room for 'contingent latitude'.

The First World War (1914-1918) - the third systemic war – (also) was a product of free energy (tensions), the anarchistic System produced at accelerating rates as a consequence of growing populations of states, and of the second law of thermodynamics that applied to its dynamics: the First World War – like all other systemic wars - was inevitable and necessary for the System, to ensure its performance and evolvability.

346 The finite-time singularity accompanied by four accelerating cycles that unfolded during the 1495-1945 period in the anarchistic System, provides a framework for making sense of historical processes; it not only explains the nature of war dynamics in the System, but also explains the direction of its development.

KEY WORDS *Singularity dynamic, Framework, Research, Rhythm, Permanent structures, Cycles, Robustness, Fragility, Structural stability, Fractal structures.*

In this statement, I comment on a number of observations Tilly makes in his study "*Coercion, Capital, and European States, AD 990-1192*" (70).

1 ***Systemic wars define the 'rhythm' of the System***
Tilly observes that, around 1500, "the increasingly connected European state system shifted to the rhythm of major wars." However, Tilly does not specify this 'rhythm, other than observing that a number of severe wars took place. As this study shows, during the 1495-1945 period the anarchistic System produced a finite-time singularity accompanied by four accelerating cycles. Four systemic wars defined the cycles (and the relatively stable periods that typically follow), that accompanied the finite-time singularity dynamic. These four wars, that are produced at an accelerating rate, can be considered 'the' rhythm of the System.

Although a number of non-systemic wars during the first exceptional period (1657-1763) were system-sized, they do not qualify as systemic (as I explain in this study). Typically, historians (including Tilly) consider the size of wars a defining characteristic; this however is not the case.

2 ***Size is not (always) a relevant criterion***
In the discussion that follows, Tilly "arbitrarily takes all wars in Levy's list during which great powers suffered at least 100.000 battle deaths." Tilly selected eighteen wars that meet this requirement. This study shows that battle deaths are not a relevant criterion to determine which wars actually had an impact on the System. During the first exceptional period (1657-1763), as just mentioned, the System produced a number of very severe wars that did not have any significant impact, other than delaying the unfolding of the singularity dynamic and making its dynamics less efficient.

3 ***Towards more permanent structures***
Tilly also discusses the four wars that I defined as systemic; historians noticed that these wars had a significant impact on the order of the System, without identifying their deterministic relationship, and the fact that they were produced by a very consistent and highly deterministic finite-time singularity dynamic.

I quote Tilly: "The cruel Thirty Years' War locked the European state system in place," and "(...) the end of the Thirty Years' War consolidated the European system of national states." Indeed, this occurred by introducing the sovereignty principle, defining a key property of units of the system. This is part of a process of self-selection, as I explained. "The Congress of Vienna (1815), ending the Napoleonic Wars, brought together representatives of all Europe's powers, not to mention many of its would-be powers… In that settlement and in the negotiations following World War I, the great powers came as close as they ever have to the deliberate collective mapping of the entire state system, right down to the boundaries, rulers, and constituents of individual states… The settlements of World War I brought the last more or less general, simultaneous, and consensual redrawing of Europe's map."

Tilly shows, with the help of two diagrams concerning joint involvement of European states in Great Power wars, one for the period 1496–1514 and the other for 1656–1674, that "… a European state system that had become more tightly knit" over time "had shifted decisively northward, and had thereby lost its Italian focus." (70) "Although the relative power and centrality of the participants altered considerably during the next two centuries, the map for the later seventeenth century shows us something like the structure that prevailed into our own time."

Tilly's observations only concern the contingent domain and are for that reason 'incomplete'. The identification of the finite-time singularity accompanied by four accelerating cycles, makes it possible to introduce the four cycles as a meaningful units of analysis. The development of properties of successive cycles show what was actually happening in the System.

Analysis from a 'cycle-perspective' shows that the robustness, fragility and structural stability of the System (successive cycles) increased linearly over time. Robustness and fragility are two sides of the same coin (as I explained); increasing robustness contributes to increasing fragility of the System.

I argue that two properties of the anarchistic System are indicative for the increasing structural stability of the structure of the System: (1) a (linear) decrease in Great Power status dynamics in Europe (the core of the System); coming to a halt (becoming zero) during the fourth international order (1918-1939), implying 'permanence' - absolute structural stability – of the Great Power status hierarchy in Europe, and (2) the sizes and 'forms' of states (the territories they controlled in Europe) simultaneous becoming permanent, and – that is a related development (property) of the System - the size distribution of states becoming increasingly 'fractal' (can be best described with a power law).

I argue that the fractality of states (also achieved during the fourth international order), is (of course) not a coincidence or just a 'peculiarity', it points to optimality: fractal state structures ensure that the production of tensions during relatively stable periods (the life span of international orders) is minimized, while (at the same time) the deployment of destructive energy during systemic wars can be optimized. The fractal structures of states were carved out by fractal activities that constitute systemic wars. Decreasing status dynamics and increasing fractality both are indicative for the increasing structural stability of the structure of the System.

347 Kondratieff economic cycles and war cycles are not synchronized and seem unrelated.

KEY WORDS *Economic cycles, Kondratieff, War Cycles, No Synchronization.*

During the 1495-1945 period, the anarchistic System produced a finite-time singularity dynamic accompanied by four accelerating cycles. Each cycle consists of a relatively stable period (international order), followed by a systemic war. The System used systemic wars to upgrade international orders, consistent with requirements of the second law of thermodynamics.

The singularity dynamic optimized the System's performance (its ability to ensure the balanced fulfillment of basic requirements of uneven states in the anarchistic System, including their security) and its evolvability (its ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars).

During relatively stable periods states focused on the balanced fulfillment of their basic requirements; during systemic wars on the other hand, states gave priority to the deployment of destructive energy, to restore their security, and ensure the implementation of upgraded orders that would take their interests into account.

During the unfolding of the finite-time singularity, accompanied by four accelerating cycles, increasing amounts of destructive energy had to be deployed, and (as a consequence) systemic wars became increasingly 'total'.

It seems reasonable to assume that the economy (economic activity at the scale of the System) and war dynamics of the System interacted: successive systemic wars required increasing amounts of resources (to produce and deploy destructive energy), at accelerating rates.

Although it is not to aim of this study to explain the interaction between the economy and war, I will now address the question whether Kondratieff cycles (1789-2003) and the cycles that accompanied the unfolding of the finite-time singularity dynamic in the period (1495-1945), were synchronized.

Kondratieff identified four cycles in economic growth dynamics during the period 1775-2000. Each cycle consists of four phases: expansion, collapse, stagnation, and recession. See below table for the specifications of respective cycles (39).

Characteristics of Kondratieff Cycles				
Cycle	Start	Peak	End	Life span
1	1789	1814	1843	54
2	1843	1864	1896	53
3	1896	1920	1949	53
4	1949	1973	2003	54

Table 107 *This table shows the characteristics of Kondratieff cycles.*

These cycles unfolded very regularly. The average life span is 53,5 years, peaks were reached at very regular intervals, the time differences between successive peaks were 50, 56, and 53 years, but these cycles did not accelerate. Various explanations are proposed for Kondratieff and other economic cycles. Proposed causes include war cycles, the demographic cycle, fiscal aspects, immigration, and social and psychological changes (39).

The question if and how the economic and war dynamics of the international system interact(ed) has been extensively researched; however, this research was never based on awareness of the existence of the accelerating war cycles identified in this study.

Kondratieff assumed that the international system produced 50- to 60-year cycles of war (39). Regarding Kondratieff's analysis, Mager explains, "The cyclic nature of wars was an integral part of his empirical data, not only as a part of the long wave but as a product of it and as a force that kept the wave in motion. He insisted that wars were the result of natural tension in a capitalist economy" (39).

This study shows that those 50- to 60-year war cycles (Kondratieff refers to) do not exist and are in fact artifacts. Kondratieff's assumptions and conclusions are, at least in this respect, not correct. However, the non-existence of 50- to 60-year war cycles does not imply that the economic and war dynamics of the System do not interact, but only that, if they interact, that different mechanisms are at work (see also: (27)).

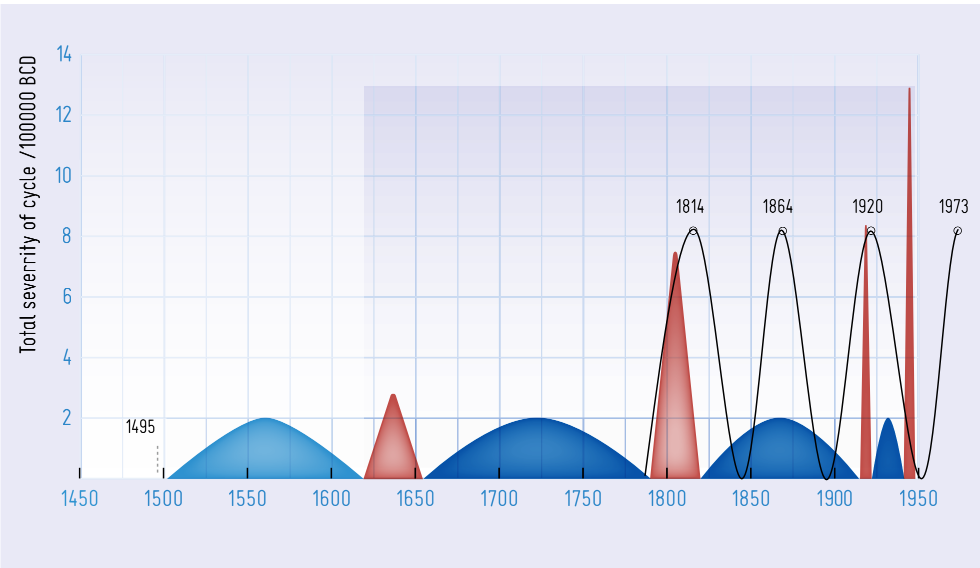


Figure 136 *shows Kondratieff and war cycles during the period 1775-1945. This figure shows that the dynamics were not synchronized. Both domains developed autonomous/independently.*

The figure shows that the anarchistic System developed its 'own' autonomous finite-time singularity dynamic accompanied by four accelerating cycles, independent of long-term economic dynamics. It seems the economic domain produced enough destructive energy to maintain the development and unfolding of the finite-time singularity dynamic, without the synchronization of cycles in both domains. However, further research is required.

348 Radicalization and terrorism (also) are responses of social systems with 'intrinsic incompatibilities'.

KEY WORDS *Tension, State, intrinsic incompatibility, Radicalization, Terrorism, Switch, Connectivity, Thresholds, Degrees of Freedom, Recruiting, Strategies, Sensitivity for terrorist attacks.*

It is possible to depict social systems as energy/tension-fields, with specific configurations. The configuration of the energy/tension-field impacts the production (when, where, amount, etc.), use (path of 'release'), and purpose (the order that will be implemented) of energy (tensions) in the system. Deterministic laws also apply to the production, and use of energy (tensions) in social systems (in states and societies.

Although deterministic laws (like the second law of thermodynamics) apply to social dynamics, some latitude is left for contingency – 'contingent latitude' – to impact the system's dynamics; contingency is accommodated as long as deterministic requirements are met.

States not only have to 'handle' (as far as that is possible) tensions (free energy) generated between states in the anarchistic System, but also within their 'own' state-structures and societies. States are 'responsible' for the balanced fulfillment of a 'dynamical' set of basic requirements of their populations and societies. External and internal energy/tension-fields interact.

It is possible to map the 'internal' energy/tension fields of states and their societies, revealing certain vulnerabilities, for example for terrorist attacks.

States and their societies differ in the types and amounts of tensions they produce, but also in (for example), the paths of least resistance their societies expose (related to the structures of their social network(s), etc.), and to what extent integrative structures of states are instrumental in provoking terrorist attacks, can produce effective responses, and are affected by such attacks.

The insights this study provides in the workings of the System, also provide some clues to acquire a better understanding of terrorism and of terrorist attacks, although I expect, that the contingent component in terror-dynamics is larger than in the war dynamics of the System; an important similarity between both dynamics is that both phenomena are energy (tension) releases, and system-responses to high tension levels.

As I argue in this study, the origin of wars as such (war as a phenomenon), cannot be explained by 'contingency'; wars are the outcome of a highly deterministic dynamic; the intrinsic incompatibility between connectivity and security in anarchistic systems, that leads to free energy (tensions) that must be put to work, at a certain point (consistent with the demands of the second law of thermodynamics). The role of contingency is – so to say – to crystallize this energy into meaningful contingent dynamics.

Terror-dynamics – as is the case with the war dynamics of the System – can only be understood, and eventually be prevented, if the 'underlying' deterministic dynamics are identified: What is the intrinsic incompatibility, that produces tensions in states and societies, that are then put to work through terror attacks? The intrinsic incompatibility between personal identities of (potential) terrorist and the dominant values and norms of societies they live in? What is the driver (control parameter) of this dynamic; connectivity? Connectivity of/with what? The purpose of wars is to relieve local issues (non-systemic wars), or upgrade the orders of the System; what is the purpose of a terror-attack from a system's perspective; to upgrade the societies order to allow for a lower energy level?

Given certain tension-levels in a society, and the configuration(s) of the energy/tension-field(s), it could be a matter of time before an individual – a single node in a vast network of individuals – 'snaps', and switches to a positive 'war' decision (conducting a terrorist attack).

The 'snap-sensitivity' of individuals differs, and depends – I assume – for example on personality structures, personal experiences and conditions, but also (as this study suggests) on the connectivity of individuals in social networks.

'Terrorist-attack' decisions, like war decisions, can be considered 'binary decisions with externalities and thresholds'; I assume that especially peer-groups are important in this respect.

Three properties in particular define the dynamics of these individuals (as is the case for the war dynamics of the System): their connectivity, the thresholds they apply to the use of violence, and the number variables (degrees of freedom, 'n') that are taken in consideration regarding these decisions.

1 ***Connectivity***
Individuals with a low number of connections, that live in a sparse social network, live (so to say) in low-connectivity regimes, are isolated, and one additional connection (incoming signal) has more impact on such a sparsely connected individual, than on highly connected individuals.

2 ***Thresholds***
Thresholds determine when individuals switch to positive attack decisions. Individuals with low thresholds concerning the application of violence, only need a low number of their connections to switch to positive terror-attack decisions, to also make such a switch. Criminals (often) have proven to possess low threshold levels regarding the use of violence; however, a low threshold can also be a result of a lack of empathy, for example as consequence of a privileged upbringing.

3 ***Number of degrees of freedom***
The number of degrees of freedom is (in this context) the number of variables an individual takes into consideration, regarding attack-decisions. If individuals define their environment in terms of intense rivalries (for example between religious ideas), their number of degrees of freedom will be reduced to two, decisions (considerations) of these individuals lack a third or fourth 'balancing' variable (degree of freedom) that constrains their behavior.

Recruiters of (potential) terrorists (individuals that are prepared to conduct an attack) isolate their targets (recruits), by 'disconnecting' them from their social network, focus on individuals with a proven track-record regarding the use of violence, provide (further) justification of the use of violence (for example through religious ideas), and reduce the number of degrees of freedom (variables) these individuals take into consideration, by radicalizing their ideas. Specific personal and psychological conditions/properties can also be exploited.

The 'conditions' just mentioned also offer clues to develop short- and long-term strategies to prevent the production of tensions in societies, and develop (preventive) strategies to tackle (individual) radicalization.

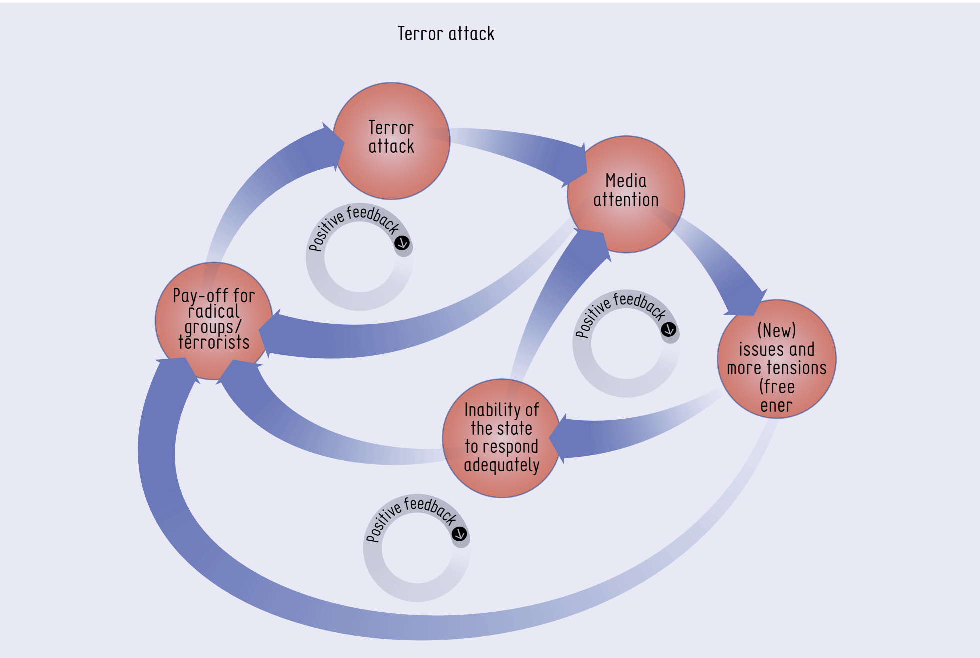


Figure 137 *This figure shows a causal loop diagram that depicts a number of closely related self-reinforcing (positive feedback) mechanisms that explain why terrorist attacks tend to produce more terrorist attacks. The basic logic of this self-reinforcing mechanism is simple: Terrorist attacks generate a number of (reinforcing) pay-offs for radical groups: (1) media attention,*

(2) (new) issues and more tensions, (3) demonstrate and negatively affect the ability (legitimacy) of states to adequately respond to (new) attacks; these pay-offs reinforce each other.

349 The high sensitivity of non-systemic wars for the initial conditions of the System, makes these type of wars intrinsically unpredictable, and difficult to explain ('reconstruct) in hindsight.

KEY WORDS *Chaotic dynamics, sensitivity for the initial conditions, Unpredictability, Explanation in hindsight.*

I argue that (normally) non-systemic war dynamics of the System are chaotic in nature; this implies that non-systemic wars are intrinsically unpredictable, because of their high sensitivity for the initial conditions of the System.

The question then is, given the high sensitivity of the sizes, intensities (and probably timings) of non-systemic wars for the initial conditions of the System, whether the sizes and intensities of non-systemic wars can in retrospect be explained sensibly and what meaning can be applied to these explanations. Historians can no doubt (in retrospect) reconstruct the events that 'unavoidably' produced wars the System actually experienced, including their sizes and intensities. Apart from the fact that historical research methods, and the explanations they provide, show fundamental shortcomings, the question is, if sensible explanations for historical events and processes can be given, even if these shortcomings are eventually taken into consideration.

However, these analyses are not much more than compelling yet highly contingent and speculative stories. Systemic and non-systemic wars are release events produced by an underlying deterministic domain that follow a number of deterministic laws. How this energy is applied in the highly contingent domain, and how these events play out, however, are highly contingent events. What meaning we give to these events in hindsight is also highly speculative.

PART IV

ASSESSMENT AND PREDICTION

So foul a sky clears not without a storm

Shakespeare, The Life and Death of King John

Introduction

Assuming that the conditions of the current (first global order (starting in 1945) are more or less similar to the conditions that prevailed during the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), this dynamic and the theoretical model I discussed in part II could serve as references for assessing and predicting the dynamics and development of the current order. The deterministic nature of the System and its regularities during the 1495-1945 period provide numerous clues for setting up a framework for assessment of the current order's dynamics and development. Such a framework and its application are the subjects of this chapter.

The structure of part IV 'Assessment and prediction' differs from the structure of the other parts: First I make a 'quick' assessment of the first global order (1945-...), next I discuss a number of concepts concerning early warning signals in complex systems, to determine their utility for the System and its dynamics; then I will complement Levy's dataset (that only concerns the period 1495-1975) to the present (2016); next, I construct a framework consisting of a number of deterministic and contingent indicators to assess the current condition of the System in more detail, followed by an assessment of the current System, and its dynamics. Following the assessment of the current global order, I construct a (speculative) model of the second finite-time singularity dynamic. Finally, I discuss a number of statements related to 'assessment and prediction'.

1 Initial assessment of the relatively stable period of the first cycle of the second finite-time singularity dynamic

In this chapter I discuss a number of observations regarding the present relatively stable period of the first global order (1945-...), that was established following the dual-phase transition (the fourth systemic war, the Second World War, 1939-1945).

1 ***Wars are an integral part of the first global order***
The first global order produced 20 non-systemic wars involving at least one Great Power in the period 1945-2016. Wars are energy releases and are not disruptions of the System. Wars are integral components of anarchistic systems and fulfill vital functions to ensure the performance and timely evolvability of the System. 'Performance' refers to the ability of the System to fulfill basic requirements of uneven states in an anarchistic System; 'evolvability' refers to the System's ability to adjust itself to changed circumstances to ensure sustained performance. Physical laws, including the second law of thermodynamics and related principles, and a number of deterministic mechanisms apply to the dynamics and development of the System.

2 ***The current System is a global system***
Through the fourth systemic war (the Second World War, 1939-1945) the System produced a dual phase transition: at the same time as dedicated hierarchies were implemented in the core of the System (Europe) resulting in the neutralization of anarchy within the hierarchies, the first global order was established. Consistent with the demands of the second law of thermodynamics, these two regional orders and the first global order are closely related and integrated. The 'European order' is an integral part of the global international order.

3 ***The System experienced a second exceptional period (1953-1989)***
As a consequence of the intense rivalry between the United States and the Soviet Union and the respective hierarchies they controlled, the System produced abnormal non-systemic war dynamics during the period 1953-1989. When the Eastern hierarchy collapsed in 1989, the number of degrees of freedom in the System became > 2, allowing for the resumption of chaotic war dynamics.

4 ***The second exceptional period distorted the development of the System***
Based on the analysis of the first exceptional period (1657-1763), I assume the second exceptional period also caused inefficiencies and probably a delay in the System's development. Contrary to non-systemic war dynamics during the first exceptional period, non-systemic war dynamics during the second exceptional period were suppressed by the high connectivity of the System.

The condition of the System during the second exceptional period is in fact comparable to the System's condition shortly before the outbreak of previous systemic wars; 'subcritical but almost critical'. At those points, states and the System were highly stable as a consequence of their high connectivity in the network of issues and states. This extended stable condition did not lead to the outbreak of a systemic war because the System could not become critical, and systemic war would ensure mutual assured destruction (MAD in nuclear strategy terminology) of rival states and hierarchies in the System. Instead this extended stable (almost critical) period led to the collapse of the Eastern hierarchy and Soviet Union, because of the impact 'external' pressure had on the balanced fulfillment of its basic requirements.

Whereas the System produced extreme non-systemic war dynamics during the first exceptional period, during the second exceptional period war dynamics were very subdued. Until the properties of the first and second cycle of the second finite-time singularity dynamic become evident, it is impossible to determine the delay this caused in the development of the System towards criticality.

5 ***The current global order has not become critical yet***

At this time (2016), the first global order of the System has not yet become critical and has not yet experienced a systemic war. The organizational arrangements that were designed and implemented through the Second World War (the dual phase transition, 1939-1945) are still in place. However, given the dynamics and condition of the current System, it is a question of when, not if, the System will become critical and produce a necessary systemic war to ensure continued compliance with the demands of the second law of thermodynamics.

6 ***The current System meets all requirements to produce a finite-time singularity dynamic***

The current global anarchistic System meets all requirements to produce critical periods and a finite-time singularity dynamic:

a *The current System produces free energy.* Populations of states still grow and demands for basic requirements continuously increase; as a consequence, the connectivity of the System and the interdependence between states is also increasing. The current global System is anarchistic in nature. The intrinsic incompatibility between increasing connectivity and security ensures the production of free energy that will eventually be put to work to upgrade the current order and ensure a lower energy state.

b War decisions of states in the current anarchistic System also qualify as '*binary decisions with externalities and thresholds.*' States in the global System form a network of binary switches regarding war decisions ('war' or 'no war').

c Chaotic non-systemic war dynamics ensure the System will reach a high-connectivity regime that enables the formation of underlying vulnerable issue clusters that will eventually percolate, resulting in criticality and systemic war.

7 ***It is unlikely that the unfolding of the second finite-time singularity dynamic can be sustained***

The undisturbed unfolding of the second finite-time singularity dynamic is unlikely, if decreasing population (growth) in the early 22nd century is not compensated by (for example) demands for (ever) higher standards of living and/or extended average life expectancies of the world population. Other factors that could hinder the unfolding of the second finite-time singularity dynamic include self-destruction of populations (and the System) by unrestrained nuclear war (for example causing irreparable damage to our climate system), and other finite-size effects, for example a lack of resources to produce sufficient destructive energy, that has to be deployed during systemic wars.

2 Early warning signals in complex systems

2.1 Introduction

Quite extensive research has been done related to early warning signals (EWS) that precede critical transitions in complex systems, in particular concerning ecosystems, climate change, earthquakes, and financial markets (14), (21), (37), (53), (54), (55), (63). Critical transitions can be considered phase-transitions. In this chapter I use these terms interchangeably.

It is suggested that generic EWS can be identified that point to the existence of tipping points and related catastrophic shifts in behavior of systems; some researchers are, however, more skeptical about these claims. In this chapter I discuss research related to the existence of EWS in various systems and I show that these EWS cannot be identified in the dynamics of the System. It seems that the dual phase transition the System experienced in 1939, belongs to a fundamentally different class of critical transitions, than discussed in above mentioned research. The critical transition the System experienced in its core and at a global level, qualifies as a dual phase transition that marked a specific growth phase in a long-term process of social integration and expansion (SIE) of populations and their organizational support systems.

2.2 Research

2.2.1 "Early-warning signals for critical transitions"

Research. "This paragraph is based on the article, "*Early-warning signals for critical transitions*", by Scheffer et al. (53). Scheffer et al. observe that "it is becoming increasingly clear that many complex systems have critical thresholds [tipping points] at which the system shifts abruptly from one state to another." "It is notably hard to predict such critical transitions, because the state of the system may show little change before the tipping point is reached. Also, models of complex systems are usually not accurate enough to predict reliably where critical thresholds may occur. Interestingly, though, it now appears that certain generic symptoms may occur in a wide class of systems as they approach a critical point."

"The dynamics of systems near a critical point have generic properties, regardless of differences in the details of each system. Therefore, sharp transitions in a range of complex systems are in fact related. In models, critical thresholds for such transitions correspond to bifurcations. Particularly relevant are 'catastrophic bifurcations', where, once a threshold is exceeded, a positive feedback propels the system through a phase of directional change towards a contrasting state. Another important class of bifurcations is those that mark the transition from a stable equilibrium to a cyclic or chaotic attractor. Fundamental shifts that occur in systems when they pass bifurcations are collectively referred to as critical transitions."

"The most important clues that have been suggested as indicators of whether a system is getting close to a critical threshold are related to a phenomenon known in dynamical systems theory as 'critical slowing down'. Although critical slowing down occurs for a range of bifurcations, we will focus on the fold catastrophe as a starting point."

"At fold bifurcation points the dominant eigenvalue characterizing the rates of change around the equilibrium becomes zero. This implies that as the system approaches such critical points, it becomes increasingly slow in recovering from small perturbations." Moreover, analysis of various models shows that such slowing down typically starts far from the bifurcation point, and that recovery rates decrease smoothly to zero as the critical point is approached." "It can be shown that as a bifurcation is approached in such a system, certain characteristic changes in the pattern of fluctuations are expected to occur. One important prediction is that the slowing down should lead to an increase in autocorrelation in the resulting pattern of fluctuations. This can be shown mathematically, but it is also intuitively simple to understand. Because slowing down causes the intrinsic rates of change in the system to decrease, the state of the system at any given moment becomes more and more like its past state. The resulting increase in 'memory' of the system can be measured in a variety of ways from the frequency spectrum of the system. The simplest approach is to look at lag-1 autocorrelation, which can be directly interpreted as slowness of recovery in such natural perturbation regimes. Analyses of simulation models exposed to stochastic forcing confirm that if the system is driven gradually closer to a catastrophic bifurcation, there is a marked increase in autocorrelation that builds up long before the critical transition occurs."

"Increased variance in the pattern of fluctuations is another possible consequence of critical slowing down as a critical transition is approached. Again, this can be formally shown, as well as intuitively understood: as the eigenvalue approaches zero, the impacts of shocks do not decay, and their accumulating effect increases the variance of the state variable. In principle, critical slowing down could reduce the ability of the system to track the fluctuations, and thereby produce an opposite effect on the variance. However, analyses of models show that an increase in the variance usually arises and may be detected well before a critical transition occurs."

"In summary, the phenomenon of critical slowing down leads to three possible early-warning signals in the dynamics of a system approaching a bifurcation: slower recovery from perturbations, increased autocorrelation and increased variance."

"In addition to autocorrelation and variance, the asymmetry of fluctuations may increase before a catastrophic bifurcation. This does not result from critical slowing down." "In the vicinity of this unstable point, rates of change are lower. As a result, the system will tend to stay in the vicinity of the unstable point relatively longer than it would on the opposite side of the stable equilibrium. The skewness of the distribution of states is expected to increase not only if the system approaches a catastrophic bifurcation, but also if the system is driven closer to the basin boundary by an increasing amplitude of perturbation."

"Another phenomenon that can be seen in the vicinity of a catastrophic bifurcation point is flickering. This happens if stochastic forcing is strong enough to move the system back and forth between the basins of attraction of two alternative attractors as the system enters the bi-stable region before the bifurcation. Such behavior is also considered an early warning, because the system may shift permanently to the alternative state if the underlying slow change in conditions persists, moving it eventually to a situation with only one stable state."

Evaluation. From Scheffer's et al. perspective, the bifurcations the System experienced in 1657 and 1763, when the nature of non-systemic wars changed, respectively, from chaotic to periodic and vice versa, qualify as critical transitions. These particular transitions are, however, not the focus of my research related to EWS in the System; I focus instead on the behavior of the System during the dual phase transition it experienced through the fourth systemic war (the Second World War, 1939-1945).

Critical slowing down, a phenomenon Scheffer et al. argue typically seems to precede critical transitions, cannot be observed in the war dynamics of the System. Autocorrelation increased only during the exceptional period (1657-1763) and concerned non-systemic war dynamics during the second relatively stable period (the second international order, 1648-1792). On the contrary, the unfolding of the finite-time singularity dynamic towards the critical connectivity threshold in 1939 shows that there was no slowing down, but instead acceleration toward infinity.

Flickering also cannot be observed in relation to the dual phase transition. However, as I explained in a number of statements in part III, there is a possible scenario in which the order in Europe, presently consisting of a single dedicated hierarchy (the European Union), is temporarily forced back to an anarchistic attractor before finally settling in a non-anarchistic stability domain.

2.2.2 "Anticipating Critical Transitions"

This section discusses the article "*Anticipating Critical Transitions*" by Scheffer et al. (55).

Scheffer et al. combine "emerging insights from two unconnected fields of research. One line of work is revealing fundamental architectural features that may cause ecological networks, financial markets, and other complex systems to have tipping points. Another field of research is uncovering generic empirical indicators of the proximity to such critical thresholds."

Research. "Sharp regime shifts that punctuate the usual fluctuations around trends in ecosystems or societies may often be simply the result of an unpredictable external shock. However, another possibility is that such a shift represents a so-called critical transition. The likelihood of such transitions may gradually increase as a system approaches a “tipping point” (i.e., a catastrophic bifurcation), where a minor trigger can invoke a self-propagating shift to a contrasting state. One of the big questions in complex systems science is what causes some systems to have such tipping points. The basic ingredient for a tipping point is a positive feedback that, once a critical point is passed, propels change toward an alternative state.”

“A broad range of studies suggests that two major features are crucial for the overall response of such systems: the heterogeneity of the components and their connectivity,” as can also be observed in the model by Watts. “How these properties affect the stability depends on the nature of the interactions in the network.”

“One broad class of networks includes those where units (or ‘nodes’) can flip between alternative stable states and where the probability of being in one state is promoted by having neighbors in that state. One may think, for instance, of networks of populations (extinct or not), or ecosystems (with alternative stable states), or banks (solvent or not). In such networks, heterogeneity in the response of individual nodes and a low level of connectivity may cause the network as a whole to change gradually - rather than abruptly- in response to environmental change. This is because the relatively isolated and different nodes will each shift at another level of an environmental driver. By contrast, homogeneity (nodes being more similar) and a highly connected network may provide resistance to change until a threshold for a systemic critical transition is reached where all nodes shift in synchrony.”

“This situation implies a trade-off between local and systemic resilience. Strong connectivity promotes local resilience, because effects of local perturbations are eliminated quickly through subsidiary inputs from the broader system”. “However, as conditions change, highly connected systems may reach a tipping point where a local perturbation can cause a domino effect cascading into a systemic transition. Notably, in such connected systems, the repeated recovery from small-scale perturbations can give a false impression of resilience, masking the fact that the system may actually be approaching a tipping point for a systemic shift.”

It is important to note that wars do not qualify as perturbations, as defined by Scheffer et al. Wars are energy releases the System produces in response to triggers.

Apart from structural properties that point to the possibility of sharp transitions, other research described by Scheffer et al. focuses on features of systems that can be used to measure how close a particular system is to a critical transition. “One line of work is based on the generic phenomenon that in the vicinity of many kinds of tipping points, the rate at which a system recovers from small perturbations becomes very slow, a phenomenon known as ‘critical slowing down.’ This happens, for instance, at the classical fold bifurcation, often associated with the term ‘tipping point’, as well as more broadly in situations where a system becomes sensitive so that a tiny nudge can cause a large change."

"The increasing sluggishness of a system can be detected as a reduced rate of recovery from experimental perturbations. However, the slowness can also be inferred indirectly from rising 'memory' in small fluctuations in the state of a system, as reflected, for instance, in a higher lag-1 autocorrelation, increased variance, or other indicators. Slowing down will precede not all abrupt transitions. For instance, sharp change may simply result from a sudden big external impact. Also, slowing down of rates can have causes other than approaching a tipping point (e.g., a drop in temperature). Therefore, slowing down is neither a universal warning signal for shifts nor specific to an approaching tipping point. Instead, slowing down should be seen as a 'broad spectrum' indicator of potential fundamental change in the current regime."

"Slowing down suggests an increased probability of a sudden transition to a new unknown state. By contrast, the information extracted from more wildly fluctuating systems suggests a contrasting regime to which a system may shift if conditions change."

Evaluation. Once the System reached the percolation threshold in 1495, it developed a 'self-propagating shift' to the eventual implementation of dedicated hierarchies in its core (Europe). Scheffer et al. define the tipping point as the moment such a self-reinforcing dynamic is set in motion (to avoid confusion: in this study, the term 'tipping point' is used in a different context and denotes the separation between low- and high-connectivity regimes of relatively stable periods).

Despite some superficial similarities between the anarchistic System and the category of systems Scheffer et al. studied, their differences are more significant. As discussed in the previous subsection, the dynamics of the anarchistic System do not show symptoms of critical slowing down; to the contrary, the System experienced an acceleration that led to its collapse when the critical connectivity threshold was reached in 1939.

2.2.3 "A state shift in Earth's biosphere"

This section is based on the article "*Approaching a state shift in Earth's biosphere*" by Barnosky et al. (8).

Research. Barnosky et al. observe: "Localized ecological systems are known to shift abruptly and irreversibly from one state to another when they are forced across critical thresholds."

In the article Barnosky et al. "review evidence that the global ecosystem as a whole can react in the same way and is approaching a planetary-scale critical transition as a result of human influence. The plausibility of a planetary-scale 'tipping point' highlights the need to improve biological forecasting by detecting early warning signs of critical transitions on global as well as local scales, and by detecting feedbacks that promote such transitions. It is also necessary to address root causes of how humans are forcing biological changes."

Barnosky et al. argue that complex interactions, feedback loops, and their hard-to-predict effects must be taken into account to forecast a system's behavior. "Particularly important are recent demonstrations that 'critical transitions' caused by threshold effects are likely. Critical transitions lead to state shifts, which abruptly override trends and produce unanticipated biotic effects. Although most previous work on threshold-induced state shifts has been theoretical or concerned with critical transitions in localized ecological systems over short time spans, planetary-scale critical transitions that operate over centuries or millennia have also been postulated." Barnosky et al. present evidence that "such planetary-scale critical transitions have occurred previously in the biosphere, albeit rarely, and that humans are now forcing another such transition, with the potential to transform Earth rapidly and irreversibly into a state unknown in human experience."

"It is now well documented that biological systems on many scales can shift rapidly from an existing state to a radically different state. Biological 'states' are neither steady nor in equilibrium; rather, they are characterized by a defined range of deviations from a mean condition over a prescribed period of time. The shift from one state to another can be caused by either a 'threshold' or 'sledgehammer' effect. State shifts resulting from threshold effects can be difficult to anticipate, because the critical threshold is reached as incremental changes accumulate and the threshold value generally is not known in advance. By contrast, a state shift caused by a sledgehammer effect – for example the clearing of a forest using a bulldozer – comes as no surprise. In both cases, the state shift is relatively abrupt and leads to new mean conditions outside the range of fluctuation evident in the previous state. Threshold-induced state shifts, or critical transitions, can result from 'fold bifurcations' and can show hysteresis. The net effect is that once a critical transition occurs, it is extremely difficult or even impossible for the system to return to its previous state."

"Recent theoretical work suggests that state shifts due to fold bifurcations are probably preceded by general phenomena that can be characterized mathematically: a deceleration in recovery from perturbations [critical slowing down], an increase in variance in the pattern of within-state fluctuations, an increase in autocorrelation between fluctuations, an increase in asymmetry of fluctuations and rapid back-and-forth shifts [flickering] between states."

"One key question is how to recognize a global-scale state shift. Another is whether global-scale state shifts are the cumulative result of many smaller-scale events that originate in local systems or instead require global-level forcings that emerge on the planetary scale and then percolate downwards to cause changes in local systems. Examining past global-scale state shifts provides useful insights into both of these issues."

Barnosky et al. observe that past global-scale state shifts coincided "with global-scale forcings that modified the atmosphere, oceans and climate. These examples suggest that past global-scale state shifts required global-scale forcings, which in turn initiated lower-level state changes that local controls did not override. Thus, critical aspects of biological forecasting are understanding whether present global-scale forcings are of a magnitude sufficient to trigger a global-scale critical transition and ascertaining the extent of lower-level state changes that these forcings have already caused or are likely to cause."

"Global-scale forcing mechanisms today are human population growth with attendant resource consumption, habitat transformation and fragmentation, energy production and consumption, and climate change. All of these far exceed, in both rate and magnitude, the forcings evident at the most recent global-scale state shift, the last glacial–interglacial transition, which is a particularly relevant benchmark for comparison given that the two global-scale forcings at that time – climate change and human population growth – are also primary forcings today." "The magnitudes of both local-scale direct forcing and emergent global-scale forcing are much greater than those that characterized the last global-scale state shift, and are not expected to decline any time soon."

Barnosky et al. propose, "Three approaches should prove helpful in defining useful benchmarks and tracking progression towards them". These can be summarized as (1) tracking global-scale changes, (2) tracking local-scale changes caused by global forcings, and (3) synergy and feedbacks.

Evaluation. Contrary to the "state shifts" to which Barnosky et al. refer, the timing of the critical connectivity threshold of the finite-time singularity dynamic can be predicted accurately. As I explained in the previous sections, the state shift the System experienced is of a fundamentally different nature than the critical transitions and state shifts Scheffer et al. and Barnosky et al. discuss.

Despite the fundamentally different characteristics of critical transitions from the dual phase transition the System experienced, the two transitions share some similarities. As is the case with state shifts discussed by Barnosky, in the System there is also global-scale forcing in the form of global population growth. The System was forced because of increasing demands for basic requirements, increasing connectivity, and the resulting increasing rivalries between states.

2.2.4 "Slowing down as an early warning signal for abrupt climate change"

In the article "*Slowing down as an early warning signal for abrupt climate change*", Dakos et al. (21) discuss the phenomenon that "in the Earth's history, periods of relatively stable climate have often been interrupted by sharp transitions to a contrasting state. One explanation for such events of abrupt change is that they happened when the earth system reached a critical tipping point. However, this remains hard to prove for events in the remote past, and it is even more difficult to predict if and when we might reach a tipping point for abrupt climate change in the future." In the article, Dakos et al. "analyze eight ancient abrupt climate shifts and show that they were all preceded by a characteristic slowing down of the fluctuations starting well before the actual shift."

Research. "Such slowing down, measured as increased autocorrelation, can be mathematically shown to be a hallmark of tipping points. Therefore, our results imply independent empirical evidence for the idea that past abrupt shifts were associated with the passing of critical thresholds. Because the mechanism causing slowing down is fundamentally inherent to tipping points, it follows that our way to detect slowing down might be used as a universal early warning signal for upcoming catastrophic change. Because tipping points in ecosystems and other complex systems are notoriously hard to predict in other ways, this is a promising perspective." "In models such tipping points correspond to bifurcations where, at a critical value of a control parameter, an attractor becomes unstable, leading to a shift to an alternative attractor. The underlying mechanism causing such extreme sensitivity at particular thresholds is typically a positive feedback."

Dakos et al. explain that the theoretical finding that, "as a rule, dynamical systems become "slow" when a critical point is approached as conditions are gradually changing." "This slowing can be used as a clue to predict upcoming critical transitions. In technical terms, the maximum real part of the eigenvalues of the Jacobian matrix tends to zero as a bifurcation point is approached. As a result, the dynamical system becomes increasingly slow in recovering from small perturbations. Although an ideal way to test whether a system is slowing down is to study its response to small experimental perturbations, this is obviously of little use for analyzing past climate change. An alternative is to interpret fluctuations in the state of a system as it responds to natural perturbations. Slowing down should then simply be reflected as a decrease in the rates of change in the system, and therefore, as an increase in the short-term autocorrelation in the time series."

As I already explained, despite some similarities in certain properties, the System developed a fundamentally different dynamic. The rate of change in the System did not slow down, but, to the contrary, accelerated.

Furthermore, Dakos et al. observe: "In all examples of abrupt climate change we analyzed, autocorrelation showed an increase in the period before the shift, suggesting that these climate systems did indeed slow down before the abrupt change, as expected theoretically for systems approaching a tipping point." "It may seem rather surprising that all cases of sharp climate shifts we analyzed were announced well before they happened by changes in the pattern of fluctuations."

"It is simply very difficult to prove what had been the mechanism behind such events in the far past. The slowing down that our analysis suggests does not point to any specific mechanism. Rather, it is a universal property of systems approaching a tipping point. Therefore, it represents an independent line of evidence, complementing model-based approaches, suggesting that tipping points exist in the climate system. Clearly, this is an important insight because it implies that, in principle, internal feedback can propel the climate system through an episode of rapid change once a critical threshold is reached." An important fundamental limitation we should keep in mind is that slowing down will only occur if the system is moving gradually toward a threshold. Therefore, transitions caused by a sudden large disturbance without a preceding gradual loss of resilience will not be announced by slowing down." "Putting our results in an even wider perspective, it is important that slowing down is a universal property of systems approaching a tipping point. This implies that our techniques might in principle be used to construct operational early warning systems for critical transitions in a wider range of complex systems where tipping points are suspected to exist, ranging from disease dynamics and physiology to social and ecological systems."

Evaluation. See previous subsections.

2.2.5 "From patterns to predictions"

As I explained, although the System experienced a phase transition (1939-1945), it did not show the typical slowing down behavior that Scheffer et al., Barnosky et al., and Dakos et al. observed in ecosystems and the biosphere when these systems reached a critical transition or state shift. Obviously the System belongs to a fundamentally different category of systems.

Carl Boetigger and Alan Hastings, in the article "*From patterns to predictions*", argue that truly generic warning signals of tipping points are unlikely to exist, and advise researchers to study transitions specific to real systems (14). My study confirms this advice.

As Boettigger et al. observe, "no 'one-size-fits-all' property" can be found "that signals the imminent collapse of a complex system... Much effort is being dedicated to finding 'generic' warning signals that apply across diverse systems. But because the phenomena identified so far are not universally associated with tipping points, nor even sure indicators of a major shift, their predictive power is uncertain. We believe that in most cases, models designed to predict when critical transitions will happen, and in what circumstances, will need to be guided by — and perhaps even generated from — data on the specific system of interest."

Although the dynamics of the System – the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) - did not have the typical features discussed in this section, the deterministic properties of the System and the resulting regularities in its dynamics and direction of development provide numerous clues that make it possible to quite accurately forecast the future behavior of the current anarchistic System.

3 Complementing Levy's dataset

Before further discussing a framework for the assessment and prediction of the war dynamics of the current (global) System, I present in this paragraph the dataset I will use to make this assessment; this dataset complements Levy's dataset that only covers the period 1495-1975 (38). The supplemented dataset covers the period 1945-2016 and, for consistency, I use Levy's terminology and criteria.

The first step is to determine what states qualify as Great Powers during the period 1945-2016. After establishing which states qualify as Great Powers, I determine what wars during the period 1945-2016 should be included in the dataset.

3.1 Identifying Great Powers

I quote Levy (38): "A Great Power is defined here as a state that plays a major role in international politics with respect to security-related issues. The Great Powers can be differentiated from other states by their military power, their interests, their behavior in general and interactions with other powers' perception of them, and some formal criteria."

"Most important, a Great Power possesses a high level of military capabilities relative to other states. At a minimum, it has relative self-sufficiency with respect to military security. Great Powers are basically invulnerable to military threats by non-Powers and need only fear other Great Powers. In addition, Great Powers have the capability to project military power beyond their borders to conduct offensive as well as defensive military operations. They can actively come to the defense of allies, wage an aggressive war against other states (including most of the Powers), and generally use force or the threat of force to help shape their external environment."

"Second, the interests and objectives of Great Powers are different from those of other states. They think of their interests as continental or global rather than local or regional. Their conception of security goes beyond territorial defense or even extended defense to include maintenance of a continental or global balance of power. Great Powers generally define their national interests to include systemic interests and are therefore concerned with order maintenance in the international system. Symbolic interests of national honor and prestige are also given high priority by the Great Powers, for these are perceived as being essential components of national power and necessary for Great Power status."

"Third, the Great Powers are distinguished from other states by their general behavior. They defend their interests more aggressively and with a wider range of instrumentalities, including the frequent threat or use of military force. They also interact frequently with other Powers... Great Powers are further differentiated from other states by others' images and perceptions of them."

"Finally, Great Powers are differentiated from others by formal criteria, including identification as a Great Power by an international conference, congress, organization, or treaty, or the granting of such privileges as permanent membership or veto power by an international organization or treaty."

Applying these criteria, I argue that only Iran (in 2011) acquired Great Power status during the period 1945-2016; no Great Powers that established their positions in 1945 lost Great Power status. I assume that Iran achieved Great Power status through its involvement in the Iraq War (2003-2011) and its sustained nuclear ambitions that were, after a series of negotiations and conferences involving the other Great Powers, settled by mutual agreement in 2015.

Other states, including India and Brazil but also Japan, lack the capabilities and typical behaviors of Great Powers as defined by Levy. Only the United States, the Soviet Union/Russia, China, Great Britain, France, and Germany qualify as Great Powers during the period 1945-2016; starting in 2011 Iran can be added to this group.

3.2 Identifying wars in the Great Power System, 1945-2016

To determine what wars qualify as "wars in the Great Power System" during the period 1945-2016, Levy's method must also be applied. In his study "*War in the Modern Great Power System, 1495-1975*", Levy identified Great Power wars until 1975.

Levy (38) defines war conceptually as "a substantial armed conflict between the organized military forces of independent political units." Levy distinguishes between two subsets of wars: (1) wars involving the Great Powers and (2) interstate wars involving the Great Powers that "consists of wars with at least one Great Power on each side of the conflict. These wars are labeled Great Power wars." Levy operationalizes the criterion "substantial" by requiring a minimum of 1000 battle-deaths, defined as the number of deaths of military personnel.This number is not restricted to the Great Powers but includes all states, "even though these other states are not included in the actual measurements of the parameters of the war".

I used a number of sources to supplement Levy's dataset: the data presented in the study "*Resort to war 1816-2007*", by Sarkees et al. for wars 120-128 and other sources (see below in table) for Wars 129-134 (52). The table below shows the complemented dataset that I will apply to the framework discussed in this chapter.

War data, 1945 - August 2016 ased on Levy (115-119), Sarkees et al. (120-128), and other resources (125-134)							
No.	War	Dates	Duration (Years)	Extent (No of GP's)	Severity (in BCD)	Size (Fraction)	GP's
115	Korean War	1950-1953	3.1	4	954,960	0.67	US, China, Fr, GB
116	Russo-Hungarian War	1956-1956	0.1	1	7,000	0.17	SU
117	Sinai War	1966-1956	0.1	2	30	0.33	GB, Fr
118	Sino-Indian War	1962-1962	0.1	1	500	0.17	China
119	Vietnam War	1965-1973	8.0	1	56,000	0.17	US
120	Sino-Vietnamese Punitive War	1979-1979	0.1	1	13,000	0.17	China
121	The Soviet Quagmire	1980-1989	9.0	1	40,000	0.17	USSR
122	Falklands War	1982-1982	0.3	1	255	0.17	GB
123	Sino-Vietnamese Border War	1987-1987	0.1	1	1,800	0.17	China
124	Gulf War	1990-1991	0.7	3	402	0.5	US, GB, Fr
125	The First Chechnya War of 1994-1996	1994-1996	2.8	1	4,000	0.17	Russia
126	Intervention in Bosnia	1995	0.1	3	27	0.5	US, GB, Fr
127	War for Kosovo	1999-1999	0.2	3	2	0.5	US, GB, Fr
128	The Second Chechnya War of 1999-2003	1999-2003	4.2	1	5,000	0.17	Russia
129	War of Afghanistan	2001-2014	13.2	4	2,955	0.67	US, GB, Fr, Germany
130	Iraq War	2003-2011	8.7	2	4,676	0.33	US, GB
131	Intervention in Libya	2011-2011	0.6	3	0	0.43	US, GB, Fr
132	War for Syria	2011-ongoing	5.5	5	20	0.71	US, GB, Fr, Iran, Russia
133	Russian-Ukraine War	2014-ongoing	2.5	1	450	0.14	Russia
134	Iranian Intervention in Iraq	2014-ongoing	2.1	1	11	0.14	Iran

Table 108 *Updated war data, 1945 - August 2016. This is an extension of the war data of Levy (38). To ensure consistency and avoid bias, I have used Levy's definitions of Great Powers, wars, and battle-deaths in my interpretation of the dataset presented by Sarkees et al. (52) and data from numerous sources; however, further validation of the dataset is required. Sarkees qualifies the Intervention in Bosnia in 1995 by the United States and NATO, including Great Britain and France, (War 125) as a phase in an intra-state war (The Bosnian-Serb Rebellion of 1992-1995). This intervention, also referred to as 'Oper-*

ation Deliberate Force,' qualifies – I assume – as a war involving Great Powers. Sarkees classifies the 'Soviet Quagmire of 1980-1989' as an 'extra-state war.' Because this war meets Levy's requirements, I assume, I added it to the data set.
*Wars 116-123 constitute the second exceptional period (1953-1989) and are shaded in grey. If the First and Second Chechnya War (respectively 1994-1996 and 1991-2003) qualify as interstate wars needs validation: These wars cause distortions in the circular trajectories in phase state. However, if excluded, this does not impact on the outcome of the assessment and predictions. The 'War of Afghanistan' (129) is arguably still ongoing, although France's involvement ended in 2012 and Great Britain's involvement ended in 2014. The Russian-Ukraine War (133) includes the annexation of Crimea by the Russian Federation (20 February - 20 March 2014) and the Russian military intervention in Ukraine (ongoing since 20 February 2014). GP: Great Powers, Fr: France, GB: Great Britain, SU: Soviet Union. The data in this table is based on Levy (38) for Wars 115-119. The data for Wars 120-128 is based on the dataset in "Resort to War 1816-2007" (52). The data for the remaining wars (127-134) were collected from: War nr. 129: "Afghanistan: Fatalities by year", icasualties.org 9 September, retrieved 14 September 2013; www.defense.gov/casualty.pdf, retrieved 29 June 2016 (through Wikipedia, retrieved 21 August 2016). War nr. 130: "Fact Sheets/Operations Factsheets/Operations in Iraq: British Fatalities", Ministry of Defence of the United Kingdom, archived from the original on 11 October 2009, retrieved 17 October 2009 (through Wikipedia, retrieved 21 August 2016). War nr. 132: "*Глава Кабардино-Балкарии подтвердил гибель двадцатого российского военного в Сирии*". Retrieved 12 August 2016 (through Wikipedia, retrieved 21 August 2016). War nr. 133: "Nuland Claims 400-500 Russian Soldiers Killed in Eastern Ukraine". Sputnik News. 10 March*

4 Identification of deterministic and contingent indicators

With the help of regularities in the dynamics and development of the anarchistic System during the 1495-1945 period – the period when the first finite-time singularity dynamic accompanied by four accelerating cycles unfolded – a number of deterministic and contingent indicators can be identified that could provide clues for the assessment and prediction of the dynamics and developments of the current order.

4.1 Deterministic indicators

The following deterministic indicators can be identified:

Deterministic indicators for assessment and prediction

	Indicator	Clarification
1	Rate of population growth	Determines the free energy that will be produced in the System and its connectivity.
2	The number of degrees of freedom of the System	Determines whether non-systemic war dynamics are chaotic or non-chaotic. Chaos is a precondition for the System to form underlying vulnerable issue clusters and to become critical.
3	Average size of non-systemic energy-releasing wars	Determines if the System is in a low- or high-connectivity regime.
4	Development of the frequency of non-systemic energy releases	Determines if the System is in a low- or high-connectivity regime.
5	Changes in centrality of nodes (development of Great Power status dynamics)	Indicator for the structural stability – organizational permanence – of the System.
6	Changes in the size and form of nodes (states)	Indicator for the structural stability – permanence of political control – in the System.
7	The nature of the size distribution of states in the System; the level of fractality of the System	Indicator for the performance of the System, and the efficiency of free energy production and (re-)distribution in the System.
8	Robustness of the System	Determines the System's sensitivity to perturbations and its ability to release free energy through non-systemic release events. This property is closely related to the System's fragility.
9	Fragility of the System	Determines the life span of relatively stable periods. This property is closely related to the System's robustness.
10	The durations of relatively stable periods and of critical periods (respectively the life span of international orders and systemic wars)	Indicator for the connectivity and pace of life of the System. Decreasing durations mean the System is approaching the critical connectivity threshold.

Deterministic indicators for assessment and prediction		
11	Amount of destructive energy that is deployed during critical periods, for which severities of systemic wars is an indicator	Indicator for the connectivity and pace of life of the System. Increasingly higher – and ultimately infinite – amounts of destructive energy means the System is approaching the critical connectivity threshold.
12	The rate of acceleration of the System	Indicator for the connectivity and pace of life of the System. Increasing and ultimately infinite acceleration means the System is approaching the critical connectivity threshold.

Table 109 *This table shows deterministic indicators.*

4.2 Contingent indicators

The following contingent indicators can be identified:

Contingent indicators for assessment and prediction		
	Indicator	Clarification
1	Development of the power flux (CINC-index).	The development of the CINC-indices indicates whether states produce destructive energy.
2	Development of alliance dynamics.	The development of alliance dynamics indicates whether states are concerned with their security and try to hedge risks.
3	Development of tensions in the System.	Tensions are manifestations of free energy, and are transformed into destructive energy.
4	The number of issues in the System and their interconnectedness.	The number of issues is indicative of the war potential of the System.
5	The number and nature of unresolved issues and their interconnectedness.	The number and nature of unresolved issues are indicative of the buildup of underlying vulnerable issue clusters.
6	Ideological reach, outspokenness, and radicalization.	Ideological developments are indicative of the mobilization potential and ultimately war preparedness of states.
7	Perceived unpredictability of wars and their properties.	The perceived unpredictability of wars, including unexpected escalation and unexpected de-escalation and containment, are indicative of the chaotic nature of these dynamics.
8	The willingness of states to get involved in non-systemic wars.	The willingness of states to engage in wars is indicative whether the System is in a low- or high-connectivity regime, and of the chaotic or non-chaotic nature of war dynamics. Chaotic war dynamics cause restraint because of the intrinsic unpredictability of these types of wars.
9	The level of representativeness of the current order.	To what degree the actual centrality of states is reflected in its order determines the level of functionality and legitimacy of the global order. The degree to which the order's rules and institutions are undermined by states with special privileges is indicative of its ability to maintain the status quo.

Table 110 *This table shows contingent indicators.*

5 Assessment of the current condition of the System

5.1 Introduction

In this chapter I make an initial assessment of the current condition of the System through the framework of deterministic and contingent indicators.

5.2 Assessment of the deterministic dynamics and properties of the System

1 ***Rate of population growth***

Population growth powered the finite-time singularity dynamic during the 1495-1945 period, determined its connectivity, and contributed to rivalries between states.

The question is whether the rate of population growth during the unfolding of the finite-time singularity dynamic in Europe (1495-1945), the core of the System, fundamentally differed from the rate of population growth at a global level starting in 1945.

The global population growth rate peaked in 1962-1963 at 2.1% (per year) and decreased to 1.2% in 2010. The global population is still growing exponentially, but its growth rate is declining. In 2100, the population growth rate is expected to be 0.06%. Around 2045 the growth rate will have decreased to the rate of 1750 (around 0.4%). During the unfolding of the finite-time singularity dynamic (1495-1945), the population growth rate increased steadily.

In order to answer above mentioned question, I calculated population growth rates during the unfolding of the finite-time singularity dynamic in Europe, and at a global scale starting in 1945. Growth rates were calculated based on change during increments of 50 years from 1500 until 2150, as follows: (population size t(2) - population size t(1)) / population size t(1).

These calculations show that global population growth rates, at least until the year 2100, are in the same range as population growth rates during the unfolding of the finite-time singularity dynamic (1495-1945), suggesting that in the coming 100 years the current global System could produce enough free energy to develop a critical condition and to initiate a second finite-time singularity. The average population growth rate in Europe during the period 1500-1950 was 23.9% and at a global scale during the period 1900-2150 will be 47.5%.

Comparison of population growth rates				
Period	Europe	Growth rate Europe	World	Growth rate world
1500	84		458	
1550	96	14.3%	500	
1600	111	15.6%	580	
1650	118	6.3%	630	
1700	125	5.9%	682	
1750	163	30.4%	791	
1800	203	24.5%	978	
1850	276	36.0%	1,262	
1900	408	47.8%	1,650	30.7%
1950	547	34.1%	2,521	52.8%
2000	729		5,978	137.1%
2050	734		9,725	62.7%
2100	639		1,0854	11.6%
2150	517		9,746	-10.2%

Table 111 *This table shows the growth rate during successive periods of 50 years in Europe (1500-1950) and at a global scale (1900-2150) (data from United Nations Population Division and related sources).*

2 ***Degrees of freedom of the System***
The first global order (beginning in 1945) experienced an exceptional period following the phase transition in the System brought on by the fourth systemic war (the Second World War, 1939-1945). This exceptional period (1953-1989) lasted until the collapse of the Eastern hierarchy in 1989. The intense rivalry between the United States and the Soviet Union temporarily decreased the number of degrees of freedom in the System to two and resulted in its ossification. In 1989 the System resumed chaotic war dynamics, a prerequisite for (eventually) becoming critical and producing a systemic war.

3 ***Average sizes of non-systemic wars***
To be discussed in paragraphs.

4 ***Frequency of non-systemic wars***
To be discussed in paragraphs.

5 ***Changes in centrality of nodes (in the deterministic domain) and associated development of Great Power status dynamics (in the contingent domain)***
The centrality of nodes in the System is not stable. Great Power status dynamics changes are manifestations of changes in the ('underlying') centrality of

nodes. Since 1945, the centrality of Great Britain and France has decreased despite their privileged positions in the current order (i.e. permanent seats in the Security Council of the United Nations, 'legal' possession of nuclear weapons, etc.), while Iran's centrality increased despite not being reflected in the formal status hierarchy of the System. I argue that Iran achieved Great Power Status in 2011.

The fact that changes in centrality still occur implies that the organizational stability of the System is not yet absolute (as was the case shortly before the dual phase transition (1939-1945)), and that a next critical period in the form of systemic war will not constitute a phase transition.

6 *Changes in the sizes and forms of nodes*

In the current System, changes in the sizes and forms of nodes (territories of states), or efforts to achieve such changes, can be observed in the Middle East where a number of states (Iraq, Syria, Libya, Yemen) collapsed, in Eastern Europe involving Russia and Ukraine, and in Asia concerning territorial claims regarding the South China Sea (involving China, Vietnam, and the Philippines, but also the United States).

Changing sizes and forms of nodes means that the System is not structurally optimized and stable, and has not yet achieved optimal fractal structures at a global scale that reflect the actual power positions of states in the System. The fact that these dynamics take place also means that the current international order is not infinitely stable and that the System is not yet poised for a phase transition. This indicator and indicator (5) (concerning changes in the centrality of nodes) are related, and dynamics during the unfolding of the finite-time singularity dynamic (1495-1945) suggest that both dynamics (changes in the centrality of nodes, and in the sizes and forms of nodes) are indicative for the structural stability of the System, and will eventually become absolute/infinite at the same time.

7 *The nature of the size-distribution of states and the level of fractality of the System*

The fact that Great Power status dynamics have resumed following the dual phase transition (1939-1945) and that sizes and forms of nodes (territories of states) both have lost their permanency implies that the current global does not reflect the actual power positions of states in the System. Power positions of states (see indicator (5)) and the territories they control (see indicator (6)) are presently in flux again.

The development of the anarchistic System during the 1495-1945 period (during the unfolding of the finite-time singularity) shows that it can be expected, that the System will through a number of successive systemic wars carve out fractal structures that will reflect the ultimate power positions of states in the (now global) System. These fractal structures will crystallize during the unfolding of the second finite-time singularity dynamic that begun in 1945. Fractal structures are – as explained in this study - instrumental in achieving a lower energy state in the anarchistic System, and in the efficient distribution of destructive energy during systemic wars (critical periods); the emergence of fractal structures is directly related to the application of the second law of thermodynamics.

8 ***Robustness of the System***
The current order periodically produces non-systemic energy releases (non-systemic wars). This implies that the System is not yet absolutely robust, and that the critical connectivity threshold will not be reached during this order: This means that the next systemic war will not (yet) constitute a (next) phase transition to a next (global) level of SIE. Consistent with indicators (5), (6), and (7), current dynamics and their properties suggest that the System requires more than one critical period (systemic war) to produce a phase transition and establish dedicated hierarchies at a global or regional level(s) of the System.

9 ***Fragility of the System***
Fragility and robustness are related properties of the System: they go hand-in-hand and are two sides of the same coin. When the robustness of the System becomes absolute and the System can no longer produce non-systemic release events because of its high connectivity, its fragility at the same time has become infinite and the System collapses. Collapse results in phase transitions to ensure the survival of populations in the System. The fact that the current global order still produces non-systemic release events means that its robustness and fragility are not yet absolute/infinite, and that the next systemic war will not precipitate the System's collapse and a phase transition.

The development of this indicator is consistent with indicators (5) through (8). All of these indicators suggest that the current global System requires more than one critical period to implement a next level of SIE.

10 ***The durations of relatively stable and critical periods represented by the life spans of international orders and systemic wars***
The current order is still unfolding, and, as this study shows, will eventually become critical and produce a systemic war. The systemic war will be instrumental in the implementation of an upgraded order that enables a lower energy state in the System, consistent with the demands of the second law of thermodynamics. Indicators (3) and (4) provide some clues to determine the expected life span of the current order; as will be discussed in next paragraphs.

11 ***The amount of destructive energy that is deployed during critical periods (systemic wars)***
Cannot (yet) be determined.

12 ***The rate of acceleration of the System***
Cannot (yet) be determined.

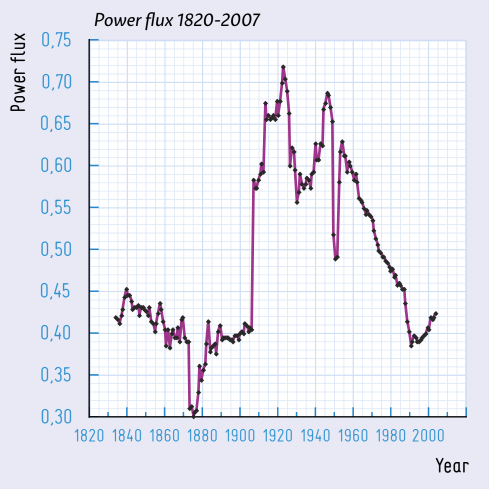
5.3 Assessment of contingent dynamics and properties of the System

1 ***Development of the power flux (CINC-index)***
CINC-index stands for the 'Composite Index of National Capability', and is based on six variables: (1) total population, (2) urban population, (3) iron and steel production, (4) energy consumption, (5) military personnel, and (6) military expenditure. CINC is s statistical measure of national power; its components represent demographic, economic and military strength. Each component (out of six) is a percentage of the word's total: Component ratio = state / global; the CINC (by state) = the sum of the six ratios / 6 (59).

Developments of the power flux (CINC-index) can be tracked until 2007 (59); subsequent data is not yet available. This study shows that the power flux does not signal upcoming systemic wars very far in advance. Significant increases in the power flux of the System preceding the third and fourth systemic wars (respectively, the First (1914-1918) and Second (1939-1945) World Wars) occurred, respectively, 2-3 years (1911-1912) and 1-2 years (1937-1938) before these wars started. Furthermore, as the analysis shows, increases in the power flux do not necessarily announce systemic wars, but can also announce non-systemic wars, or can be just random fluctuations.

There were no significant changes in the power flux during the period 1945-2007 other than a steady increase that started with the resumption of chaotic non-systemic war dynamics around 1989, when non-systemic wars stopped being 'subdued' as a consequence of the intense rivalry between the United States and the Soviet Union, and the hierarchies they controlled.

Figure 138
This figure depicts the total power flux measured by the sum of the CINC-indices of Great Powers in the System (multiplied by 10). Sudden changes in the power flux cannot be attributed to the war dynamics of the System, but rather to states that acquired or lost their Great Power status. This is for example the case in 1898, when the United States acquired Great Power status. Because of the short 'lead-time' of significant changes in the power flux before systemic wars, the power flux is not a useful indicator for the upcoming war dynamics of the System.



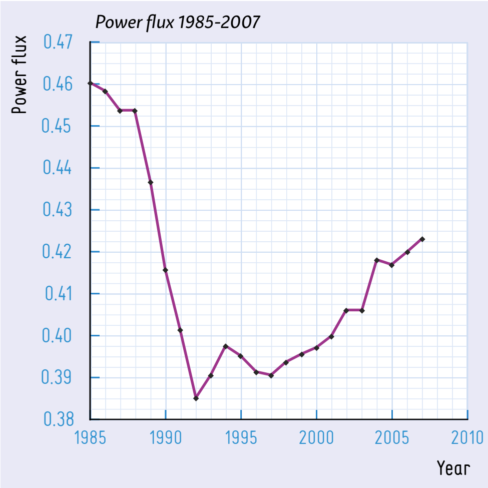


Figure 139
This figure provides a more detailed look at the development of the power flux during the period 1985-2007. The resumption of chaotic war dynamics led to a steady increase in the power flux that, I assume, still continues.

2 *Development of alliance dynamics*

I define 'alliance dynamics' as the number of alliances that were started or ended by Great Powers in the System each year during the period 1816-2013. As is the case with the power flux, alliance dynamics are of limited practical value as reliable EWS. Furthermore, as this analysis also shows, alliance dynamics are not necessarily related to systemic wars, but also indicate the formal establishment of new states (decolonization), rivalries during the Cold War (1945-1989), and the collapse of the Eastern hierarchy (1989).

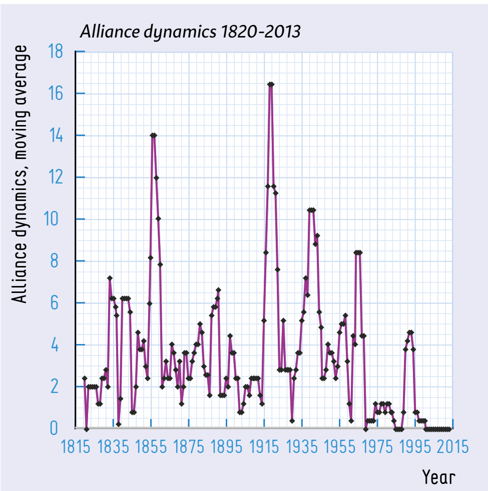


Figure 140
This figure shows the alliance dynamics of the System as the moving average (five observations) of the sum of alliances started or ended by Great Powers in the System in increments of five years during the period 1820-2013 (25).

3 *Development of tensions in the System*

This indicator cannot be quantified. Current developments in the System suggest tension levels are rising. Great Power rivalries appear to be increasing within Europe, between the United States and Russia regarding the Ukraine and Syria, and between the United States and China regarding the South

China Sea for example, in addition to increasing tension levels in the Middle and Far East and regionally in Africa.

4 ***The number of issues in the System, and their interconnectedness***
See also indicator (3). Because of the simultaneous involvement of Great Powers in a number of issues, for example involvement of the United States and Russia in Syria and the Ukraine, issues can become connected. A relevant question is if the current order is in a low- or high-connectivity regime, and if increased connectivity of the network of states and issues will result in an increase in the average sizes of non-systemic wars (in case the order is in a low-connectivity regime), or in increased local stability of states and as a consequence in a decrease in the average sizes of non-systemic wars (in case the order is in a high-connectivity regime).

The current, more restraint behavior of the United States and of Russia suggest that the current order is in its high connectivity regime. This would imply that issues and tensions are not being 'released' through non-systemic wars, but instead contribute to further growth and crystallization of underlying vulnerable issue clusters.

As this study shows, through growth and crystallization of underlying vulnerable issue clusters, that eventually percolate the System, the System 'charges' itself, becomes critical and produces a systemic war.

5 ***The number and nature of unresolved issues, and their interconnectedness***
See indicators (3) and (4).

6 ***Development and reach of ideologies, and level of radicalization***
This indicator cannot be quantified; however, ideologies are apparently becoming more radical, including religious ideologies in the Middle and 'nationalism' and political positions in Europe, Russia, China, and the United States.

7 ***Perceived predictability of wars and their properties***
Since 1989, wars are perceived as increasingly unpredictable, consistent with the chaotic nature of non-systemic war dynamics.

8 ***The willingness of states to get involved in non-systemic wars***
States seem to have become more reluctant to get involved in wars. This effect can be attributed to a high-connectivity regime of the current order (see also point (4)) or the chaotic and intrinsically unpredictable nature of non-systemic wars.

9 ***The level of representativeness of the current order***
The current global order is the outcome of the fourth systemic war (the Second World War, 1939-1945) that constituted a dual phase transition.

International orders are a reflection of power positions of states in the System during the systemic wars that produced them. Following the Second World War (1939-1945), the United States, the Soviet Union (later Russia), China, Great Britain, and France assigned privileges to themselves to ensure that their interests – and the status quo of the international order they established - would be served. These privileges include permanent membership and veto-right in the Security Council of the United Nations, and a legal monopoly on the possession of nuclear weapons, formally laid down in the Treaty on the Non-Proliferation of Nuclear Weapons in 1970. This 'nuclear' privilege serves the power positions of the five states, and of the status quo (of the current order): by forbidding nuclear weapon possession for potential rival states, those states are unable to pose a serious threat to the structural stability of the international order.

The current order is, however, obsolete, and does not represent current power positions and the current hierarchy of influence in the System. Great Britain and France derive their positions from their privileges in the current System, not from their actual power and influence; on the other hand, other more powerful and influential states are not sufficiently represented in the current order. As a consequence, the current order is becoming increasingly dysfunctional and will be increasingly challenged by rising powers.

The obsolescence and dysfunctionality of the current order is also evident in the behavior of privileged Great Powers. For example, in 2003 the United States manipulated the United Nations and the Security Council to legalize its attack on Iraq, in 2014 Russia infringed on sovereign rights of the Ukraine, and China is challenging sovereign rights of other states in the South China Sea. These actions undermine the current order from which these actors have most to gain - and lose.

The (temporary) structural stability, but also (the seed of) the collapse of international orders in anarchistic systems, both lie in the rules and institutions these orders are based on; it is as a consequence of the increasing connectivity of the System and rivalries between Great Powers, however just a matter of time before international orders collapse under their own contradictions.

6 Further quantitative analysis of the first global order (1945-...)

6.1 Introduction

In this chapter I discuss four observations concerning the properties and development of the first global order (1945-...).

6.2 The System produced fundamentally different non-systemic war dynamics before and after 1989.

The war dynamics during the period 1945-1989, denoted as the 'second exceptional period,' and during the period that followed differ fundamentally.

	Properties of non-systemic war dynamics (1945-2016): Two distinct periods (Based on the assumption that two periods can be identified)			
		1945-1989 (Exceptional period)	1989-2016 (Chaotic)	1945-2016
1	Number of wars (n)	9	11	20
2	Duration of period	46	27	71
3	War frequency	0.20	0.41	0.28
4	Average war size	0.24	0.39	0.32

Table 112 *This table shows some quantitative properties of the second exceptional period (1945-1989), the period that followed (1989-2016), and of the full period (1945-2016).*

This analysis confirms the fundamental differences in the nature of the war dynamics during the second exceptional period and the period that followed. During the exceptional period, the war frequency was significant lower as was average war size.

Contrary to the periodic war dynamics during the first exceptional period (1657-1763) the abnormal non-systemic war dynamics during the second exceptional period were much more subdued, for fear of escalation and self-destruction. The only exception was the Korean War (War 115, 1950-1953) the first non-systemic war following the fourth systemic war (the Second World War, 1939-1945). Some historians argue that the year 1953 marks a significant escalation in the rivalries between the superpowers of the United States and the Soviet Union.

If 1953 is the start year of the second exceptional period, the conclusion that the first global order experienced two fundamentally different types of non-systemic war dynamics is even more convincing. This implies that the nature of non-systemic war dynamics during the first global order were as shown in the table below.

The nature of non-systemic war dynamics during the first global order (after 1945.)				
	Period	Nature of war dynamics	Degrees of freedom (n)	Remarks
1	1945-1953	Chaotic	n > 2	Cannot be proven. The only non-systemic war during this period was the Korean War; its ending marked the start of the intensification of the US-SU rivalry.
2	1953-1989	Non-chaotic	n = 2	The System produced seven wars during this subdued and ossified period.
3	after 1989	chaotic	n > 2	The System produced nine wars of varying sizes and intensities/severities.

Table 113 *The nature of non-systemic war dynamics during three distict periods during the first global order (1945-...).*

It is now possible to make adjustments to table 111 (*Properties of fundamentally different war dynamics (1945-2016), based on the assumption that **two** periods can be identified*), assuming the first global order can be divided in three different periods.

Properties of non-systemic war dynamics (1945-2016): Three distinct periods (Based on the assumption that three periods can be identified)					
		1945-1953 (Chaotic)	1953-1989 (Exceptional period)	1989-2016 (Chaotic)	1945-2016
1	Number of wars (n)	1	8	11	20
2	Duration of period	8	36	27	71
3	War frequency	0.125	0.22	0.41	0.28
4	Average war size	0.67	0.19	0.39	0.32

Table 114 *This table shows the division of the first global order into three distinctive periods, and their respective properties.*

In the figures below, I show the trajectory in phase state (sizes and intensities) of non-systemic wars. During the second exceptional period (1953-1989) it is not possible to identify orbits in the trajectories. The fact that, since 1495, the System never otherwise experienced such an extended series of non-systemic wars only involving one Great Power (also) confirms that the period 1953-1989 indeed was exceptional.

From 1989 onwards, it is possible to identify circular-like trajectories in phase state; I attribute these orbits to the chaotic nature of non-systemic war dynamics. Obviously Great Powers became less constrained in engaging in war, because the risk of self-destruction was significantly reduced.

Figure 141
This figure depicts the trajectories in phase state of non-systemic Wars 116-123 during the second exceptional period (1953-1989): x-axis: size, y-axis: intensity. The sizes of these wars are very subdued (except for war 117 (Sinai War, 1956), only one Great Power was involved), and typically occurred outside of Europe (except for war nr. 116 the Russo-Hungarian War, 1956-1956).

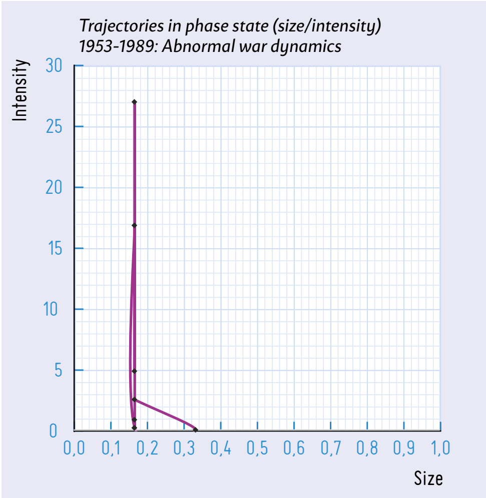


Figure 142
This figure depicts the trajectories in phase state of non-systemic Wars 124-134 from 1989 to the present (2016). The size of these wars is now more variable: the trajectories in phase state point to the chaotic nature of these war dynamics.

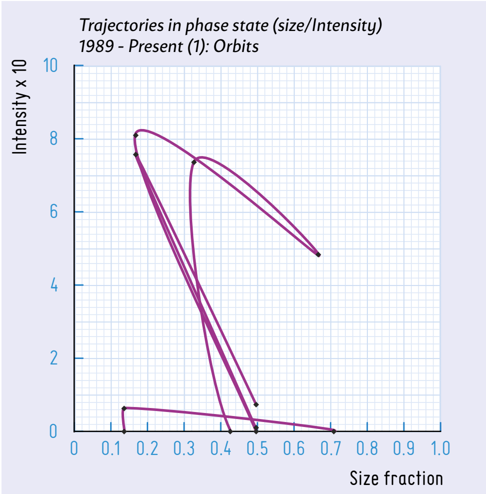
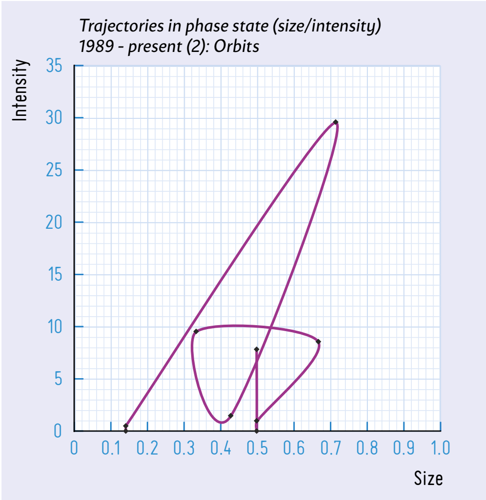


Figure 143
This figure depicts the trajectories in phase state of non-systemic Wars 124-134 from 1989 to the present (2016), however in this figure the First and Second Chechnya War respectively during 1994-1996 and 1999-2003 are excluded and the orbits (circular trajectories) are more pronounced. The question is if these two wars qualify as interstate wars. Exclusion of these two wars from the analysis does not impact on the assessment and predictions.



6.3 The non-systemic war frequency of the current order suggests that the System is in its first relatively stable period of a second finite-time singularity.

I observed that Great Power status dynamics have resumed during the first global order (begun in 1945) after coming to a halt during the fourth international order (1918-1939) that preceded the dual phase transition caused by the fourth systemic war (the Second World War, 1939-1945). Consistent with the previous observation, I also found that not only is the organizational stability of the System's status hierarchy no longer absolute/infinite, but also its physical organization, since state borders again are contested in certain regions in the cyrrent order.

These properties, and the fact that the current order's robustness is not absolute, suggest that the System will not produce a phase transition during the next critical period to meet the demands of the second law of thermodynamics. These indicators suggest that the global System can still produce upgraded orders within the current anarchistic system, without implementing dedicated hierarchies; there still are opportunities for upgrading orders in an anarchistic context.

The war frequency during successive international orders of the first finite-time singularity dynamic (1495-1945) decreased linearly; the war frequency of the current chaotic period (1989-present) is 0,41 and approximates the war frequency – 0,37 - of the first international order (1495-1618) of the first finite-time singularity dynamic (1495-1945). This similarity suggests that the current global order is part of the first cycle of a second finite-time singularity that is now unfolding on a global scale.

Further analysis (concerning the (expected) life span of the first global order (1945-2020) shows that the second finite-time singularity dynamic will also be accompanied by four accelerating cycles (1945-2187).

Properties of international orders (1495-...)			
International order	Period	War frequency	Average size
1	1495-1618	**0.37**	0.39
2	1648-1792	0.24	0.39
3	1815-1914	0.17	0.31
4	1918-1939	0.05	0.71
5 (First global order)	1945-2016	0.28	0.32
Suborder 5a	1945-1953	0.13	0.67
Suborder 5b	1953-1989	0.22	0.19
Suborder 5c	1989-2016	**0.41**	0.39

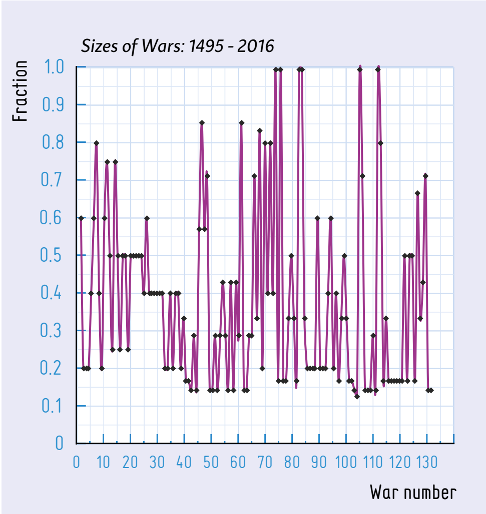
Table 115 *This table shows the war frequencies and average sizes of non-systemic wars during*

the five international orders. I have subdivided the first global order into three suborders: a chaotic order from 1945-1953 (suborder 5a), a non-chaotic order from 1953-1989 (the second exceptional period, suborder 5b), and a chaotic order that started in 1989 after the collapse of the Eastern hierarchy (suborder 5c).

6.4 Analysis of war data suggests that the current order reached the tipping point in 2011, and now is in its high-connectivity regime

With the help of the complemented war data it is possible to determine if a tipping point can be identified in the non-systemic war dynamics of the current global order; to determine if a tipping point exists I used the size of non-systemic wars and how the size developed over time, as an indicator.

Figure 144
This figure shows the size of successive wars the System produced during the period 1495-present (2016); size is defined as the number of Great Powers involved in wars divided by the total number of Great Powers in the System. The x-axis numbers refer to war numbers. Data from Levy (38) and extended data set.



In the figure below, I show the moving average of five successive wars for the same data. This gives a clearer picture of the size development of non-systemic wars in the System.

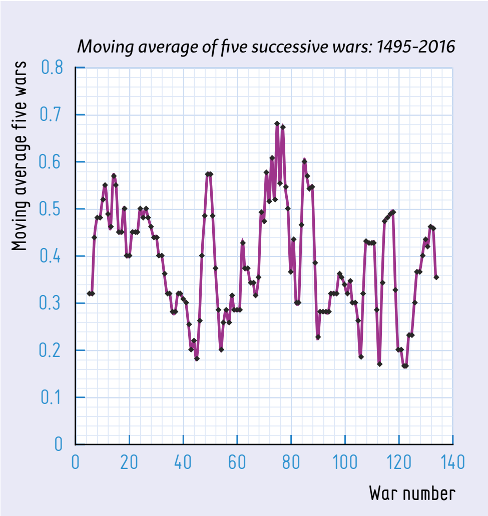


Figure 145
This figure shows the moving average sizes (in terms of fraction) of groups of five successive wars in the System (1495-2016). Data from Levy (38) and extended data set.

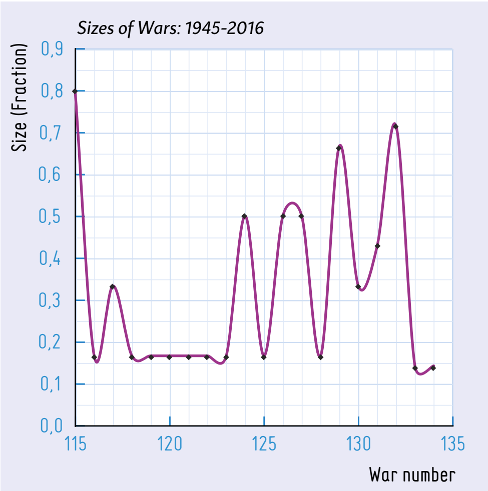


Figure 146
This figure shows the sizes (in terms of fraction) of successive non-systemic wars (nr's 115-134) during the period 1945-2016. Data from Levy (38) and extended data set.

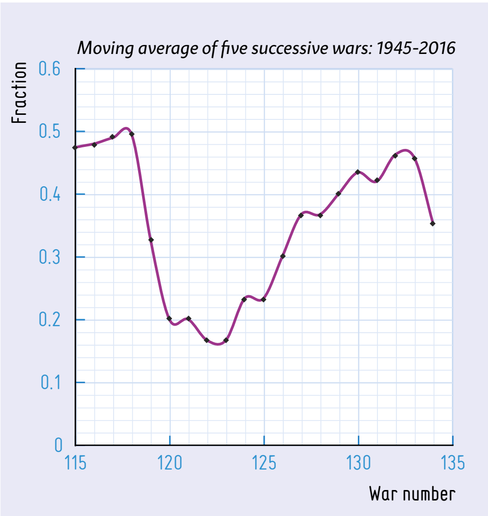


Figure 147
This figure depicts the moving average size (based on five wars, in terms of fraction) during the first global order (1945-present, war nr's. 115-134). The maximum found in numbers 1-4 is related to the sizes of the Second World War and the Korean War, a lag effect typical for moving averages. Data from Levy (38) and extended data set.

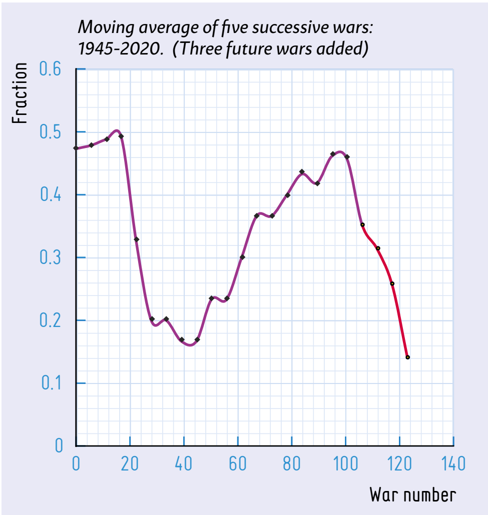
This analysis suggests that the year 2011 – 'The War for Syria' – constitutes the tipping point of the current order, an assumption that must be confirmed by the size of the next non-systemic war(s). If this is the case, it implies that the System indeed is (since 2011) in the high-connectivity regime of the current order; consistent with a number of indicators (EWS) in the contingent domain, as discussed. However, this could turn out to be a premature conclusion: Validation of the dataset is required.

Typically, during high-connectivity regimes states become increasingly stable because of their high and increasing connectivity within the network of states and issues. In the contingent domain, this means that Great Powers become increasingly reluctant to engage in new wars. As explained in this study, during high connectivity regimes the buildup of free energy accelerates, but instead of being released, it crystallizes into underlying, and eventually percolating, vulnerable issue clusters.

6.5 The System will become critical around 2020 and produce a systemic war to ensure that it meets the demands of the second law of thermodynamics

Assuming that 2011 indeed is the tipping point of the current relatively stable period, and assuming that the moving average will further decrease, it is possible to estimate when the current order will become critical.

Figure 148
This figure shows the moving average size (in terms of fraction) of non-systemic wars (based on five wars) if three future wars occur involving one Great Power. Data from Levy (38) and extended data set (nr's 115-134).



The figure above shows the moving average of war size when three hypothetical future non-systemic wars in which only one Great Power participates are added to the data set. This simulation is based on the assumption that the current order is in its high-connectivity regime, and is unable to produce non-systemic wars of a significant size.

This 'experiment' suggests that the System needs one to three non-systemic wars involving one (or two analysis shows) Great Powers to push the moving average to the same level as when the System became critical during the first finite-time singularity dynamic (1495-1945).

In the case of *one* additional non-systemic war involving one or two Great Powers, the moving average will (about) reach the critical fraction (of the moving average of the System) before the outbreak of the second systemic war (the French Revolutionary and Napoleonic Wars, 1792-1815). In the case of *two to three* additional non-systemic wars, the System will reach the critical fractions of the moving average before the outbreak of the first, third, and fourth systemic wars.

In the figure below I have added three still fictional systemic wars (135-137) involving only one Great Power.

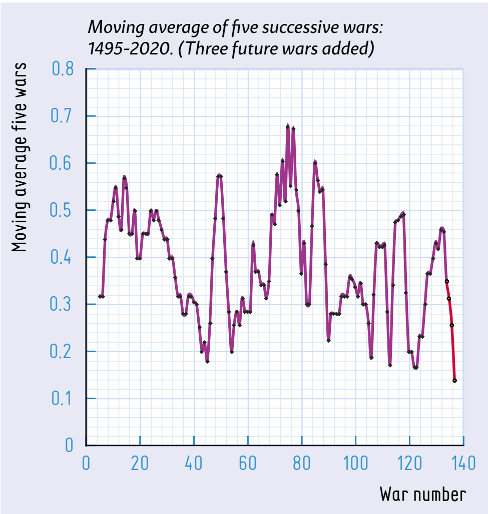


Figure 149
In this figure, three (still hypothetical) wars involving only a single Great Power are added to the dataset. The addition of these 'fictional' wars makes it possible to identify what number of wars is necessary to reach the critical fraction of the first global order of the second finite-time singularity dynamic. Data from Levy (38) and extended data set (nr's 115-134).

If these assumptions are correct, the next question is how long it would take the System to produce one to three non-systemic wars to reach the critical fraction of the first global order. This study shows that, although non-systemic wars are normally chaotic in nature, during successive relatively stable periods they developed (in some respects) very regularly.

With the help of the calculated war frequencies during the current order (see above table), and by ignoring the chaotic nature of the System, it is possible to speculate on how long it will take for the System to develop one to three non-systemic wars, and thus to become critical and produce a systemic war.

I distinguish between two scenarios; a scenario with a war frequency of 0.28 (the average of the first global order 1945-2016), including the second exceptional period (1953-1989), and a scenario with a war frequency of 0.41, concerning the chaotic period 1989-2016.

'Criticality analysis' of the first global (1945-...)			
War frequency	One additional war	Two additional wars	Three additional wars
0.28 (average 1945-2016)	3.6 years (2018)	7.2 years (2021)	10.8 years (2025)
0.41 (average 1989-2016)	2.4 years (2016)	4.8 years (2019)	7.2 years (2021)

Table 116 *In this table I show how many years it could take, depending on the war frequency of the current order, to produce one, two, or three additional wars. This is a speculative calculation. The years (in the table) refer to the year the war would be produced with a baseline at 2014, the last year the System produced a non-systemic war (number 134).*

I assume that the System requires 2-3 non-systemic wars to become critical and that probably the higher war frequency (0,41) of the period 1989-2016 is applicable to these three additional (still fictional) non-systemic wars. This implies that the System will become critical around 2020 (2019-2021) and will produce a systemic war to implement an upgraded order that will allow for a lower energy state of the System and ensure compliance with the second law of thermodynamics.

The size of the next non-systemic war will be indicative of the likelihood of this scenario. If it turns out that 2011 is not the tipping point, that implies that a systemic war will be produced at a later stage than suggested in this scenario.

7 Evaluation

7.1 Introduction

In this section, I evaluate the usability of the framework for assessing the current condition of the System and predicting its dynamics and development, as just applied and discussed. The following subjects will be discussed: (1) a number of factors and conditions that complicate assessment and prediction and (2) similarities and differences between the first (1495-1945) and second (beginning in 1945) finite-time singularities.

7.2 Complicating factors

A number of factors complicate the analysis of the war data and prediction of the next systemic war. These factors include:

1 ***The unknown impact of abnormal war dynamics during the second exceptional period (1953-1989)***

During the second relatively stable period (1648-1792) of the first finite-time singularity, the System temporarily produced abnormal non-systemic war dynamics from 1657 to 1763. I denoted this period as the first exceptional period.

During this period, the number of degrees of freedom of the System was reduced to two as a consequence of the intense rivalry between Great Britain and France. This led to the 'downgrading' of non-systemic war dynamics from chaotic and more constrained to period and more extreme war dynamics. I argue that these periodic war dynamics were suboptimal and caused a time-delay in the development of the second relatively stable period toward criticality (systemic war) and inefficiencies in the energy production and releases of the System.

During the first global order (beginning in 1945), an intense rivalry between the United States and the Soviet Union again produced an exceptional period from 1953 until 1989. Contrary to the abnormal war dynamics during the first exceptional period, these abnormal war dynamics were not more extreme or more regular than chaotic war dynamics, but were very small in size. The difference in types of abnormal war dynamics, both defined by two degrees of freedom, can be explained by the connectivity of issues that were at stake during the exceptional periods. In the case of the second exceptional period, issues were very tightly connected and destructive energy that was preventively deployed could cause self-destruction. During this exceptional period, the intense rivalry between two Great Powers led to the System's ossification. The energy state of the System was very high, but energy could not be released other than by a series of wars only involving one Great Power outside of the erstwhile core of the System (Europe). When the Eastern hierarchy collapsed in 1989, the System resumed its default chaotic war dynamics.

I calculate that the first exceptional period caused a delay of about 13 years in the development of the second cycle and in the unfolding of the first finite-time singularity dynamic. A thirteen-year delay on a theoretical life span of the second cycle of 154 years is about eight percent, and arguably qualifies as relatively insignificant; above all, it shows how the System was able to recover very quickly from abnormal war dynamics: The System produced a percolating underlying vulnerable issue cluster necessary to achieve criticality only within 29 years (in 1792). The abnormal war dynamics during the first exceptional period probably also contributed to the formation of this underlying cluster.

The question now is if, and to what extent, the second exceptional period (1953-1989) also caused a delay in the development of the current global order toward criticality.

Because of the different response of the System to intense rivalries during the first and during the second exceptional periods, it is not clear if the delay caused by the first exceptional period predicts a delay caused by the second exceptional period. Did the ossification of the System have the same impact as hyper-excited dynamics during the period 1657-1763? Did the abnormal war dynamics during the second exceptional period have an impact at all?

Because I use the moving average as an indicator for whether – and when - the current order will become critical and produce a systemic war, this complication does not impact the prediction for the timing of the next systemic war. However, it means that the life span of the first global order must be used with reservations to calculate the life spans of the next cycles, assuming a second finite-time singularity consisting of more than one cycle unfolds, as I argued in previous paragraph.

2 *The timing of a tipping point in the war dynamics of the first global order*

Based on the moving average of sizes of five successive non-systemic wars, it is possible to identify a tipping point, when an order changes from a low- to a high connectivity regime. At the tipping point, the increased local stability of states results in a decrease in the size of non-systemic wars and also in the buildup of underlying vulnerable issue clusters that will lead to criticality of the System. I identify 2011 as the tipping point of the current global order. Assuming the System will only produce small wars involving one or two Great Powers, the System will become critical and produce a systemic war around 2020. These conclusions could be premature: the moving average of the sizes of non-systemic wars during relatively stable periods does not always develop regularly; moreover, the supplementary dataset I made for 1975-present requires validation.

3 *The duration of low- and high-connectivity regimes*

If 2011 is the tipping point of the current (first global) order, and the System becomes critical around 2020, this means that the current global order is able to produce percolating vulnerable issue clusters – to 'charge' iteslef – that will cause a global systemic war in about ten years. That seems to be relatively fast. However, issues related to the intense rivalry between the United States and the Soviet Union (and between states that formed the respective hierrachies these two states controlled) that seemed to be settled through a number of 'agreements' following the second exceptional period (1953-1989, the Cold War), could re-emerge – as current developments suggest - and cause underlying vulnerable issue clusters to grow and percolate relatively fast(er). Probably renewed rivalries between Britain and France during the period 1763-1792, were 'reinforced' by 'unresolved' tensions during the first exceptional period (1657-1763), and also contributed to the 'fast' emergence of the second systemic war (the French Revolutionary and Napoleonic Wars, 1792-1815).

Life spans of low- and high-connectivity regimes of international orders of the first finite-time singularity (1495-1945) do not show any regularities, and do not provide any clues that are useful to estimate the life spans of the low- and high-connectivity regimes of the current global order.

4 *The impact of fundamental transformations: From hierarchies to networks as optimal solutions to meet the demands of the second law of thermodynamics*

Although the System is still a state-system, a number of developments point to some fundamental changes that could be underway. These changes include: (1) the transformation of the System from a state-system with hierarchical organizational structures to a system consisting of a network of border-crossing communities. If such a transformation is actually taking place, the System can achieve lower energy states demanded by the second law of thermodynamics by crystallizing in network structures rather than by settling in hierarchical structures. (2) Fundamental changes in the nature of warfare from wars between states to wars between populations and communities. These two changes are closely related, interact, and are self-reinforcing. I assume change (1) and (2) are closely related.

The development of organizational structures in Europe shows, on one hand, that state-structures become obsolete when states reach a certain level of interdependence, and on the other hand, that top-down hierarchical structures are insufficient and ineffective in integrating the former European states, utilizing economies of scale and scope, and ensuring the balanced fulfillment of the basic requirements of all Europe's populations.

If such a fundamental change takes place, implying the dissolution of state structures and regional hierrachies at a global scale, and replacement of these structures by networks of communities, this could – I assume – (eventually) impact on the dynamics of the second finite-time singularity dynamic (1945-...) during its unfolding. The impact (also on predictions) – if there is any - cannot be determined at this stage.

5 *The non-availability of a model to run scenarios and test relationships between variables and parameters*

Models of the System and its dynamics are not yet available. Models and simulations with these models (as has become common practice in climate change research), will be helpful in further analyzing and understanding the System's dynamics, and predict its behavior.

8 Constructing a (speculative) model of the second finite-time singularity dynamic

8.1 Introduction

Based on this study and the assessment discussed in this chapter, I assume that the current global System that emerged through a dual phase transition in 1945, meets the basic conditions to produce a second finite-time singularity dynamic. Population growth ensures an increase in connectivity and the production of free energy (tensions in the anarchistic System), and the demands of the second law of thermodynamics and other laws and deterministic principles of course still apply.

If a second finite-time singularity unfolds, it leads to the implementation of a number of upgraded orders and eventually to the implementation of a dedicated hierarchy or other organizational solution for the System to meet the demands of the second law of thermodynamics, but now at a global scale. This is the next and probably the final step in the long-term process of social integration and expansion (SIE), towards global integration.

It is possible to construct a hypothetical second finite-time singularity dynamic, based on the insights the dynamics and development of the System, the first finite-time singularity (1495-1945), provide us. I assume (regarding this theoretical model) that the second exceptional period (1953-1989) did not have a significant impact on the development of the first cycle, and the unfolding of the second finite-time singularity dynamic.

Further factors that are not taken into consideration, but probably impact on the dynamics and unfolding of the second finite-time singularity dynamic, are related to the initial conditions of both singularity dynamics, that differ fundamentally. These differences include differences between: (1) the structure of the System in 1495 consisting of a collection of loosely connected diverse units without any significant collective organization versus the structure of the System in 1945 consisting of states that are organized in a clearly defined anarchistic order, (2) the level of interdependence between units/states of the first international order of the first and second finite-time singularity dynamics, (3) the level of empowerment of individuals and communities in the System, and (4) the pace of life of the System during the first cycle) of the first (start 1495 and second (start 1945) finite-time singularity dynamics. Further research is required to determine if and how these differences impact on the unfolding of the second finite-time singularity dynamic. Each developmental stage of the unfolding second finite-time singularity dynamic – but also simulations with models of finite-time singularities – makes it possible to further fini-tune and gauge the second -finite-time singularity dynamic.

8.2 Determining the life spans of cycles

If the first global order indeed becomes critical around 2020, its lifespan is 75 years.

A crucial condition for this scenario to unfold is that population growth of states in the System continues to 'power' the development and unfolding of the second finite-time singularity dynamic). This seems not to be the case until 2185 (see table 119), or a decrease in population (growth) is compensated by an increase in life expectancies and demands for higher standards of living. population growth starts stagnating in the beginning of the 22nd century.

Assuming (1) the second finite-time singularity dynamic accelerates consistently with the same rate as the first, (2) systemic wars the System produces do not lead to collective self-destruction, and (3) finite-size effects do not impact the unfolding of the second finite-time singularity dynamic, the second finite-time singularity dynamic will reach its critical connectivity threshold (anarchistic end state) around 2185.

To make these speculative calculations, I made use of the theoretical model of the first finite-time singularity dynamic.

Ratio's and acceleration factors of the theoretical model of the first singularity dynamic		
	Lifespan cycle	Acceleration factor of cycles
1	168	NA
2	153	0.91
3	102	0.67
4	22,5	0.22

Table 117 *This table shows the acceleration factors of successive cycles of the theoretical model of the first finite-time singularity dynamic, accompanied by four accelerating cycles.*

Timing of a (still) hypothetical second finite-time singularity dynamic (Based on certain properties of the 'theoretical' first finite-time singularity dynamic)			
	Start	End	Life span (years)
First global order (rel.st. per.)	1945	2020	75
Fifth systemic war	2020	2036	17
Second global order (rel.st. per.)	2036	2104	68 (factor 0.91 applied)
Sixth systemic war	2104	2119	15 (factor 0.91 applied)
Third global order (rel.st. per.)	2119	2165	46 (factor 0.67 applied)
Seventh systemic war	2165	2175	10 (factor 0.67 applied)
Fourth global order (rel.st. per.)	2175	2185	10 (factor 0.22 applied)
Eighth systemic war	2185	2187	2 (factor 0.22 applied)

Table 118 *In this table I show the timing of successive global orders and critical periods of a (still) hypothetical second finite-time singularity dynamic (1945-2187). The life spans of successive global orders and systemic wars are calculated by applying the same acceleration factor to the second, third, and fourth cycle as I determined for the undisturbed theoretical version of the first finite-time singularity dynamic. The lifespan of the first systemic war produced by the second finite-time singularity dynamic (the fifth systemic war), I calculated by applying the same ratio as applies to lifespan of the first relatively stable period (138) and lifespan of the first systemic war (30) of the first cycle of the theoretical model of the first finite-time singularity dynamic (0.22).*

This model suggest that it will take 17 years (2020-2036) to design and implement the second global order. The model also suggests that the global anarchistic System will reach its critical connectivity threshold – the anarchistic end state – around 2185. I assume that at that point (through the eighth systemic war (2185-2187)), the System will produce a phase transition and implement a global non-anarchistic system: the second finite-time singularity is instrumental in implementing the next 'level' of social integration and expansion (SIE).

8.3 Determining the severities of cycles

It is also possible to speculate about the severity of the next systemic war. Analysis of the first finite-time singularity dynamic shows that there exists a consistent ratio between the total severity of non-systemic wars during relatively stable periods and the severity of the systemic wars that follow. I assume that the severity of a war is a measure for the destructive free energy that is deployed. This ratio is related to the robustness, or connectivity, of international orders. See the table below. However, as I explain in point (7) of this chapter, another 'start point' (other that the just mentioned ratio) could also be used to construct (and test) a model of the second finite-time singularity dynamic, leading to higher severities of systemic wars.

The total severity of non-systemic wars the first global order produced in the period 1945-present (Wars 115-134) is 1.091.088 battle-connected deaths of military personnel (Great Powers only). If the System must still produce three more systemic wars to become critical, and if these wars have the same average severities as the 20 preceding wars, the total severity of the first global order (the first relatively stable period of the first cycle of the second finite-time singularity dynamic) will be 1.254.751 battle-connected deaths of military personnel (Great Powers only).

Because both finite time singularity dynamics are accompanied by four accelerating cycles, (and the predicted war frequency of the relatively stable period of the first cycle of the second finite-time singularity dynamic, is 'close' to the actual war frequency of the relatively stable period of the first cycle of the first finite-time singularity dynamic), I assume the (more or less the same) release ratios will apply to the second finite-time singularity dynamic.

The ratio that applies to the first cycle is 0,65 (65% of the total energy will be released during the systemic war); than 1.254.751 BCD (Great Powers only) is equivalent with 35%; 65 % (that is the energy released through the fifth systemic war (2020-2036)) is equivalent with 2.330.252 BCD (Great Powers only).

The severities of the severities of the 6-8 systemic wars, I calculated by applying the acceleration rate for severities of systemic wars (based on the first finite-time singularity dynamic (1495-1945).

Speculative calculation of the severity of systemic wars of the second finite-time singularity dynamic accompanied by four accelerating cycles (1945-2187)
(Severity = number of battle-connected deaths of military personnel, Great Powers only)

	Severity systemic war	Acceleration factor	Release ratio	War frequency
Cycle 1	1,971,000		0.65	0.37
Cycle 2	4,900,000	2.49	0.85	0.26
Cycle 3	8,100,000	1.65	0.93	0.17
Cycle 4	11,100,000	1.37	0.97	0.05
Cycle 5	2,330,252		0.65	0.33
Cycle 6	5,802,327	2.49	0.85	
Cycle 7	9,573,840	1.65	0.93	
Cycle 8	13,116,161	1.37	0.97	

Table 119 *This table shows the estimated severity of the systemic wars that will – the speculative model suggests – be produced by the second finite-time singularity dynamic accompanied by four accelerating cycles during the period 1945-2187. I have used the severity of successive systemic wars of the theoretical ('corrected') first finite-time singularity dynamic as a reference. I have calculated the severity of the fifth systemic war (2020-2036), by applying the release ratio to the estimated total severities of non-systemic wars during the relatively stable period of the first cycle (1945-2020). The severity of the sixth, seventh and eighth systemic war I have calculated by applying the acceleration rate (based on the theoretical model of the first finite-time singularity dynamic).*

8.4 Determining properties of cycles

In previous paragraphs I 'calculated' the life spans of the cycles of the second finite-time singularity dynamic, and the severities of systemic wars this singularity dynamic produces.

The regularities I identified in the dynamics and properties of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), and the theoretical 'undistorted' - model I constructed, can also be used to determine the properties of the cycles of the second finite-time singularity dynamic.

In this paragraph I determine the properties of successive cycles, again based on a number of speculative assumptions. I assume:

1) The System produces 23 non-systemic wars during the first relatively stable

period of the second finite-time singularity dynamic; this number is based on the assumption that the System reaches with 23 non-systemic wars the critical fraction of the first cycle and then becomes critical; this study suggests (assuming the data base is accurate) around this will happen around 2020.

2) I assume that the absolute number of non-systemic wars the second finite-time singularity dynamic produces during four cycles, decreases linearly from 23 during the relatively stable period (1945-2020) of the first cycle, to 1 non-systemic war during the relatively stable period (2175-2185) of the fourth cycle. The number is based on the assumption that the (global) anarchistic System reaches absolute robustness and its anarchistic end state at the end of the fourth relatively stable period (2175-2185).

3) I assume the decrease in the number of orbits also is linear (as is the case during the first finite-time singularity dynamic); I also assume the same ratio applies to the number of non-systemic wars and the number of orbits, as during the first finite-time singularity dynamic (1495-1945, respectively 0.20 - 0.18 - 0.19 average 0.19). This implies that the second relatively stable period would produce ≈ 4.4 - 2.0 - 1.5 - 0.2 orbits during respective relatively stable periods of the second finite-time singularity dynamic.

Properties of cycles of the second finite-time singularity dynamic (1945-2187)				
	Life span Relatively stable periods	Non-systemic wars	War frequency	Orbits
1	75	23	0.31	4.4
2	68	15	0.22	2.0
3	46	8	0.17	1.5
4	10	1	0.10	0.2

Table 120 *This table shows the 'estimated' properties of cycles of the second finite-time singularity dynamic that will also be accompanied by four accelerating cycles (1945-2187).*

8.5 Identifying contingent dynamics that point to the condition and development of the current order

Dynamics of the deterministic domain are – must be – synchronized with - dynamics in the contingent domain; this is achieved through the security dilemma and interacting self-fulfilling prophecies.

In this section I discuss a number of contingent events that could occur leading up to or during the next systemic war (2020-2036). Whether these exact events will play out cannot be predicted; however, deterministic requirements must be met to ensure the compliance of these events with demands of the second law of thermodynamics.

In above paragraphs I made calculations to predict deterministic dynamics and properties of the System's dynamics from a top-down deterministic perspective. These calculations predict that the System will become critical and produce a systemic war around 2020. The deployment of destructive energy during this systemic war will cause about 2.3 million battle-connected deaths of military personnel (Great Powers only); the war will last about 16 years. To become critical, the System still must produce one to three non-systemic wars involving one or two Great Powers during the period 2016-2022. These deterministic properties define the latitude – the playing field - for contingent dynamics.

Based on a preliminary and superficial analysis of current dynamics, which are chaotic and unpredictable in nature, a number of the following contingent developments could play out during the next systemic war. These events can be derived from vulnerable issue clusters that are now crystallizing in the System through interacting self-fulfilling prophecies of states, populations, and communities:

1 ***In the Middle East***
Escalation of conflicts; further collapse and fragmentation; direct confrontation (as opposed to confrontation through proxies) between Iran and Saudi Arabia; establishment of an enlarged sphere of political influence by Turkey; direct confrontations between the United States and Russia; direct involvement of Israel.

2 ***In Eastern Europe***
Re-establishment of a sphere of influence in Eastern Europe by Russia, implying a pushback of Western influences and NATO; escalation of the war between Russia and Ukraine; direct confrontation between Russia and other European States; direct involvement of NATO and the United States; direct confrontation between Russia and the United States; exposure and enlargement of political divisions in Europe; fragmentation of the European Union; a new approach to the integration of Europe based on network structures.

3 ***Far East***
Enlargement of China's sphere of influence, including the South China Sea; China's goal to re-establish political control over Taiwan; escalation of resentments and rivalries between China and Japan; confrontation between North and South Korea; direct confrontation between China and the United States.

4 ***Central Asia***
Direct confrontation between Pakistan and India.

5 ***Africa***
Further escalation of various rivalries in Africa leading to further fragmentation.

6 ***Global communities***
Radical groups making use of the lack of order in the System in efforts to promote their radical ideas and enhance control over populations; reduced coverage and functionality of the Internet, and reduced global mobility hampering radical groups' abilities to mobilize and direct terrorists in other states.

7 ***Europe and the United States***
Manifestation of terrorist threats 'from within' that are inspired by radical global communities; imposition of strict controls over populations by states in response to threats that undermine the legitimacy of governments.

8 ***Use of nuclear weapons***
Reluctance of established Great Powers in possession of nuclear weapons (the United States, Russia, China, Great Britain, and France) to use these weapons directly against each other to avoid further escalation (and retaliation); escalation of regional rivalries between Pakistan and India, North and South Korea, and Israel and Middle Eastern states, result in the employment of nuclear weapons.

9 ***Hybrid warfare***
Wars will be hybrid, involving not only armies that represent states, but also populations and ad hoc coalitions of empowered individuals and communities. The totality of war will reach a new level.

These and other events could occur. However, 'whatever happens', the contingent dynamics during the next systemic war must meet the demands of the second law of thermodynamics; this also is the case for the upgraded second global order that will be designed and implemented through the fifth systemic war.

8.6 Identifying properties and the direction of development of next global orders

Based on the deterministic nature of the dynamics and certain properties of the System, it is possible to determine some key properties of the next orders that will be implemented through systemic wars. These successive orders each allow for a lower energy state of the System than their predecessors, as is demanded by the second law of thermodynamics.

Ultimately, assuming the second finite-time singularity dynamic can unfold until its critical connectivity threshold is reached, the System will be forced by the second law of thermodynamics to make a transition to a non-anarchistic global order, according to speculative calculations made in the previous paragraph this would be around the year 2185.

The System still awaits a long-term process of development involving a series of systemic wars at an accelerating pace. Furthermore, the integrative structures that will ultimately emerge will not resemble a government, as we define it now. The non-anarchistic global order that ultimately will be implemented will resemble a network of communities and facilities at different scales of the System, will function on the basis of shared values and norms, and will be optimized to utilize parallel decentralized processing capabilities, similar to immune systems, and other aspects of life forms.

The second global order (potentially beginning around 2025) will have the following properties, I assume:

1) The second global order will be more stable and robust, but also more fragile than the preceding first global order (1945-2020). Its life span will be shorter than the life span of the first order (75 years (2020- 1945)). Its war frequency will be lower.

2) The second global order will include a number of regional orders that are integral parts of the global order, to meet the demands of the second law of thermodynamics and allow a lower energy state of the System. Regional dedicated hierarchies could, for example, be imposed in the Middle and Far East; it can also be expected that the order in Europe (the current European Union) will be upgraded.

3) The second global order will also include networks of global and regional communities that transcend the more formal orders referred to in (1) and (2), and that contribute to a lower energy state of the new order.

4) The second order is a next step in a longer-term SIE process. The System cannot establish a non-anarchistic order at a global level through a single systemic war; that is what calculations with deterministic properties of the System show. The fifth systemic war will be the first in a series that constitutes a second finite-time singularity dynamic that will also be accompanied by a number of accelerating cycles.

5) The second global order and global orders that follow, will increasingly reflect that (the concept of) national defense through states is becoming obsolete. This is the case for two reasons in particular: (1) the fact that states (given their function and organization) are to a high degree 'responsible' for the free energy they (unavoidably) produce in anarchistic systems, and – as this study shows – the second law of thermodynamics wants to reduce, and because of (2) the ('global') range of destructive energy that can be deployed by states (for example through aircraft, and missiles, see also Boulding (15) and the now global range of destructive energy that can be deployed by empowered individuals and communities that leverage the Internet, social media and global mobility. States and their governments derive their legitimacy from their ability to contribute to the fulfillment of basic requirements of their populations, including their security. States however have become increasingly vulnerable; this undermines their utility and legitimacy. This

vulnerability of states and their governments is purposefully targeted by radical communities, and will be further magnified by the inability of states to respond proportionally to these threats.

8.7 Comparison of both finite-time singularity dynamics

If this hypothetical scenario unfolds, it will mean that the (global) anarchistic System will reach the critical connectivity threshold in 2185 and produce a phase transition. This phase transition would result in the implementation of a global non-anarchistic structure, the ultimate level of social integration and expansion that can be achieved by the System.

Properties of the first and (hypothetical) second finite-time singularities		
	First finite-time singularity	Second finite-time singularity (hypothetical)
Life span	450 years (1945-1495)	242 years (2187-1945)
Number of cycles	4	4
Ultimate outcome	Simultaneous implementation of dedicated hierarchies in Europe and a first order with a global scale	Implementation of a non-anarchistic structure at a global scale

Table 121 *This table shows the basic properties of the first and (hypothetical) second finite-time singularities. Other scenarios*

The scenario I discuss in this chapter is based on the assumption that the ratio between the sum of severities of non-systemic wars during relatively stable periods (international orders) and severities of systemic wars, during the first finite-time singularity dynamic which was accompanied by four accelerating cycles 1495-1945, can be used to predict the severity of the next (fifth) systemic war. The ratios developed very regularly, during the first finite-time singularity dynamic, as shown and explained in this study.

Application of this ratio predicts a severity of the next systemic war (2020-2036) of 2,330,252 BCD (Great Powers only).

During the first finite-time singularity dynamic the severities of successive systemic wars exactly 'obeyed' above mentioned ratios. However, regarding the severities of the first four systemic wars, I also identified another regularity, that can be used as a start point to construct a model of the second finite-time singularity dynamic: In all four cases, the total severities of wars (non-systemic and systemic) during the four successive cycles the first singularity dynamic produced, were a more or less similar proportion - on average 2.43 percent - of the population size of the core of the System (Europe). In fact, an oscillating dynamic can be observed.

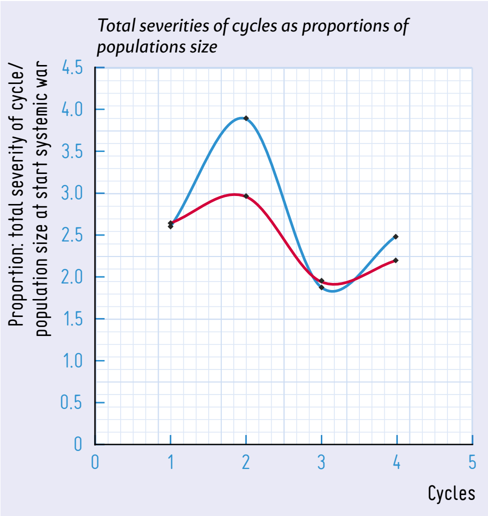


Figure 150
This figure shows the total severities of successive cycles of the first finite-time singularity dynamic (1495-1945) as a proportion of the population size of the System (Europe) at the start of the four systemic wars (that define the cycles. The average of the theoretical (corrected) model is 2.43 percent.
Actual finite-time singularity in blue, theoretical finite-time singularity in red.

If the proportion (percentage of the size of the global population) is used as a start point for the construction of the second finite-time singularity dynamic, the total severities of the four cycles the System will produce, will be significantly higher. For example, 2.43 percent of 7.7 billion (global population size in 2020) is 18.7 million BCD (great Powers only), during the first cycle.

Either way, this inconsistency (when the first finite-time singularity dynamic is used as a reference) suggests, that there (probably) was a 'reset' of parameters, the moment the System 'globalized' by means of the fourth systemic war (1939-1945, the Second World War).

The actual timing and severity of the next systemic war makes it possible to calibrate the model of the second finite-time singularity dynamic.

9 Related statements

In this chapter I discuss a number of statements that are closely related to the assessment and prediction of the dynamics and development of the System (1945-...).

350 A number of regularities in the dynamics of the System can be used as early warning signals (EWS); a distinction can be made between EWS in the deterministic and contingent domains of the System.

KEY WORDS *Singularity dynamic, EWS, Deterministic domain, Contingent domain, Contingent latitude.*

On the basis of the deterministic nature and properties of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), it is possible to identify a number of deterministic indicators that could be used as EWS for upcoming dynamics and developments. It is also possible to identify certain contingent indicators that are synchronized with, or are a contingent reflection of, deterministic properties of the System. The deterministic domain determines the latitude – playing field – of contingent dynamics in the System.

351 The size development of non-systemic chaotic wars since 1989 suggests that the first global order reached its tipping point in 2011 and is at present in its high-connectivity regime, when states become increasingly stable because of their increasing connectedness in the network of issues and states.

KEY WORDS *First global order, Fifth cycle, Tipping point, High-connectivity regime, Local stability, second law of thermodynamics, 2020)*

During the period 1495-present, the System produced five relatively stable periods during which states and their populations could fulfill their basic requirements to ensure their survival; the first four relatively stable periods were each followed by a systemic war to ensure compliance with the second law of thermodynamics.

Cycles in the System, 1495-present				
Cycles of the first finite-time singularity dynamic (1495-1945)				
	Cycle	Life span order	Accompanying systemic war	Life span systemic war
1	1	1495-1618	First systemic war (Thirty Years' War)	1618-1648
2	2	1648-1792	Second systemic war (French Revolutionary and Napoleonic Wars)	1792-1815
3	3	1815-1914	Third systemic war (First World War)	1914-1918
4	4	1918-1939	Fourth systemic war (Second World War)	1939-1945
Cycles of the second finite-time singularity dynamic (1945-present)				
	Cycle	Life span order	Accompanying systemic war	Life span systemic war
5	1	1945-2022	Fifth systemic war (Third World War)	2020-2036

Table 122 *This table specifies the five cycles of the System; the timing of the fifth cycle is speculative.*

Analysis of war data since 1945 suggests that, during the relatively stable period that followed the fourth systemic war and dual phase transition (the Second World War, 1939-1945), three subperiods can be distinguished: (1) a chaotic period (1945-1953), (2) an exceptional period (1953-1989) when war dynamics were subdued because of the intense rivalry between the United States and the Soviet Union, and (3) a chaotic period (1989-present) that started when the Eastern hierarchy collapsed (1989) and chaotic war dynamics resumed.

The sizes of non-systemic wars the System produced during the first global order (beginning in 1945) suggest that the order reached its tipping point in 2011; from that moment in time the order has been in its high-connectivity regime with increased local stability of states. This can be attributed to the high connectivity of states to issues in the network and resulted in a decrease in the average size of non-systemic wars, despite tensions (free energy) being produced at an accelerating rate. Instead of being released, these tensions crystallize(d) in underlying vulnerable issue clusters that eventually percolate the System and cause it to become critical and produce a systemic war. This sequence of events is imposed on the System by the second law of thermodynamics, which determines when the System must adopt upgraded orders to allow for a lower energy state. Analysis suggest that the System becomes critical around 2020.

352 The timing, duration, and severity of the hypothetical fifth systemic war can be deduced from deterministic properties of the first finite-time singularity dynamic (1495-1945).

KEY WORDS *Criticality, Non-systemic wars, Fifth systemic war, Singularity dynamic, Properties.*

Typically, during high-connectivity regimes non-systemic wars come to a halt before producing a massive systemic energy release (systemic war). This study suggests that the moving average size of successive non-systemic wars is a reliable indicator for when the System will reach a critical fraction. The progression of the moving average of non-systemic wars during the current global order suggests that the System needs one to three more non-systemic wars involving one or two Great Powers to reach the critical point around 2020.

The war frequency of successive relatively stable periods during the first finite-time singularity dynamic decreased linearly to eventually reach a value near zero during the fourth relatively stable period (1918-1939) preceding its collapse (1939). If the war frequency of the current sub-period (1989-present, f = 0.41) and the start year (2014) of last non-systemic war (the Iranian Intervention in Iraq, number 134) are applied, the System should produce one to three non-systemic wars during the period 2016-2020. The System should become critical during this period and then produce a systemic war to ensure its compliance with the second law of thermodynamics.

If the predicted life span of the fifth relatively stable period (75 years, 1945-2022) is indicative of the life span of the systemic war that will follow, calculations based on the properties of the first finite-time singularity dynamic suggest that the duration of the next systemic war will be about 16 years. Similar assumptions and calculations suggest that the System will release destructive energy during the fifth systemic war causing about 2.3 million battle-connected deaths of military personnel of Great Powers.

353 A number of developments suggest that state-structures are no longer optimal solutions for populations to ensure fulfillment of their basic requirements.

KEY WORDS *Basic requirements, Populations, States, Optimal, Collapse, Empowerment, SIE.*

The following developments indicate that the state is challenged as the optimal solution for populations to ensure their collective survival:

1 ***Collapse of states***
States in the Middle East and Africa collapse because they lose legitimacy when they are not able to fulfill the basic requirements of their populations. It should be remembered that the 'state' is an European invention, and is the outcome of a long-term evolutionary process that interacted with specific European conditions.

2 ***Economies of scale and scope that can be leveraged in SIE***
When states in the System reach a certain level of interdependence they can no longer be maintained in an anarchistic System because of the tensions they produce; at that point, the second law of thermodynamics demands the imposition of dedicated hierarchies to achieve a lower energy state in the System. These hierarchies can be leveraged by former states and their populations to achieve economies of scale and scope that further enhance their abilities to fulfill basic requirements.

3 ***Empowerment enables more optimal forms of organization***
The empowerment of individuals and communities by the Internet, social media, and global mobility enables alternative structures organized into cross-border networks of communities. This alternative form of organization provides opportunities for the second law of thermodynamics to 'choose' networks instead of hierarchies to achieve lower energy states. Radical communities and individuals with global reach leverage networks to challenge the current order.

During the first finite-time singularity dynamic armies of states carved out state Fractal structures. The empowerment of individuals, communities and populations, the (as a consequence) more hybrid 'structure' of wars, will (increasingly) carve out a system consisting of these community-structures (a network of (nested) networks).

These and other forces influence the competition between SIE and fragmentation in the System.

354 The System has not experienced critical slowing down; its dynamics have accelerated instead.

KEY WORDS *Critical slowing down, Acceleration, Growth dynamic, second law of thermodynamics.*

Research on the behavior of complex systems suggests that critical slowing down often precedes critical transitions, including phase transitions. Critical slowing down describes the phenomenon of systems becoming increasingly slow in recovering from small perturbations. Apart from the fact that wars are symptoms of the System's intrinsic dynamics and energy releases and are not perturbations of the System, the System has not shown critical slowing down; to the contrary, its dynamics accelerated towards a critical transition.

The anarchistic System does not belong to the category of systems that typically experience critical slowing down before producing a critical transition. I argue that there is a growth dynamic, and that the System must accelerate because of the increasing amounts of free energy produced by growing populations. The second law of thermodynamics does not tolerate high levels of free energy, and imposes upgraded orders on the System to allow for a lower energy state.

355 World population growth can power a second finite-time singularity dynamic at least until the first decennia of the 2^{n}d century.

KEY WORDS *Population growth, Second singularity dynamic, Critical connectivity threshold.*

Forecasts predict that the world population will continue growing until the early 22nd century. Population growth powered the first finite-time singularity dynamic (1495-1945), and also powers the second finite-time singularity that has been developing since 1945. Negative population growth could mean that the second finite-time singularity cannot sustain its development and unfolding until it reaches its critical connectivity threshold. However, the finite-time singularity dynamic is probably not only powered by population growth, but also by an increase in average life expectancy and by populations demanding higher standards of living. Further research is required to determine the contribution of these three components.

356 A number of conditions must be met for the System to produce a singularity dynamic. The current global System meets all requirements to produce the next finite-time singularity.

KEY WORDS *Second finite-time singularity dynamics, Conditions.*

The current global System meets all requirements to produce a second finite-time singularity dynamic accompanied by accelerating cycles. These conditions are: (1) population growth, (2) applicability of the second law of thermodynamics and other laws and deterministic mechanisms, (3) war decisions that qualify as binary decisions with externalities and thresholds, and (4) states that are connected in a network of binary switches.

357 The Western hierarchy that evolved in the European Union is now confronted with challenges similar to those that led to the collapse of the Eastern hierarchy (1989).

KEY WORDS *European Union, Challenges, Collapse, Fragmentation.*

The current first global international order (begun in 1945) and an upgraded order of two dedicated non-anarchistic hierarchies in Europe were established through a dual phase transition, in which the fourth systemic war (the Second World War, 1939-1945) was instrumental. The System produced the dual phase transition when in 1939 it reached the critical connectivity threshold (the singularity in finite time). These upgraded orders were required for the System to meet the demands of the second law of thermodynamics.

Initially, two dedicated non-anarchistic hierarchies were established in Europe: A Western hierarchy controlled by the United States and an Eastern hierarchy controlled by the Soviet Union. The two superpowers and their respective hierarchies engaged in an intense rivalry that led to the second exceptional period (1953-1989); the second exceptional period was characterized by its subdued war dynamics.

The integrative structures of the Eastern hierarchy and the Soviet Union, however, struggled to fulfill the basic requirements of their populations and to maintain a viable internal balance. The threats to which the Eastern hierarchy and the Soviet Union had to respond led to ever-increasing demands on resources, and contributed to the Eastern hierarchy's eventual collapse and fragmentation (1989). External pressures and demands led to internal collapse and fragmentation; the Soviet Union's and Eastern hierarchy's integrative structures were – as explained – insufficient.

The fragmentation of the Eastern hierarchy and the Soviet Union led to a temporary disorientation in Russia (the core of both these collapsed structures), and to the absorption (integration) of a number of former members of the former Eastern hierarchy and the Soviet Union into what would crystallize as the European Union.

The roles now seem to be reversed. Whereas in the period 1945-1989 the Eastern hierarchy struggled and eventually collapsed because integrative requirements could not be met, the European Union is now confronted with similar challenges; its incomplete and unbalanced integrative structures are increasingly under pressure and must cope with (threats to) fragmentation of its structures.

358 The current international order has become increasingly dysfunctional and is no longer representative of actual power and influence positions.

KEY WORDS *Dysfunctionality, Fifth order, First global order, Inability to reorganize, Systemic war, second law of thermodynamics.*

The current first global international order (begun in 1945) has become increasingly dysfunctional. The privileges that dominating Great Powers (the United States, the Soviet Union/Russia, China, Great Britain, and France) allocated to themselves do not reflect the actual power and influence positions of these states in the System anymore. Not only have Great Britain and France lost power and influence, and other non-privileged states (Iran and India for example) have gained power, but also the current arrangements of the first global order no longer seem to meet the requirements of the United States, Russia, and China. The three states that formally benefit the most from the current arrangements also increasingly challenge the current order and undermine its legitimacy: The United States purposefully misguided the United Nations to legitimize its attack on Iraq in 2003 by providing unsubstantiated proof of Iraq's imminent threat to international peace and stability; China willfully challenges legal arrangements that underpin the current international order to expand its influence in the South China Sea;

Russia infringed on the sovereignty of the Ukraine to expand its influence and to reestablish its position in the Great Power status hierarchy of the System.

As was the case for preceding orders, the current order lacks arrangements to reorganize itself and realign actual positions of power and influence with privileges that are allocated to states. This structural shortcoming is somewhat by design: International orders are designed to maintain the status quo to provide structural stability, and preserve the priviliges of dominant states that decided on the order's arrangements. As long as an order is established within an anarchistic System, states lack sufficient trust of other states to peacefully reorganize and upgrade the existing order with means other than war. The moment reorganization becomes necessary to avoid further buildup of tensions and the System becoming critical, the level of trust between states further deteriorates: negotiation (no longer) is an option.

These developments and mechanisms cause the System to become critical and produce a systemic war (in 2020 this study suggests) to implement an upgraded order that enables a lower energy state, consistent with the demands of the second law of thermodynamics. Interacting self-fulfilling prophecies ensure that the deterministic and contingent domains are synchronized.

359 Rules of international orders in the System are based on a 'snapshot' of the power and influence positions of states in the System and can only be optimal for a certain period of time.

KEY WORDS *States, International order, Rules, Dominant states, Privileges, dysfunctionality, Collapse.*

International orders become increasingly dysfunctional. Dysfunctional international orders in the contingent domain have equivalents in the underlying deterministic domain of the System. At a certain point, privileges that certain states enjoy do not reflect actual power and influence positions of states in the System any longer.

Dysfunctional orders – and accompanying dynamics – have their 'equivalents' in the deterministic domain. Dysfunctional orders are contingent representations of unbalanced networks in the deterministic domain.

In the deterministic domain, nodes in a network represent states in the System. Nodes (as well as states) differ from each other in some fundamental respects: nodes produce different amounts of free energy and make different contributions to the overall structural stability of the network. The free energy potential of nodes and their structural stability contribution are two sides of the same coin and are functions of their centrality and connectedness in the network.

The network of nodes performs a function. The network must ensure a balance between shared and conflicting requirements of nodes: nodes are dependent on each other for the input of energy (the fulfillment of their basic requirements), but dependencies also create security issues. During the unfolding of the finite-time singularity dynamic (1495-1945), these contradictory dynamics intensified and led to the production of ever-increasing, and ultimately infinite, amounts of free energy.

Nodes in the network – states in the System – interact on the basis of a number of rules. These rules are embedded in international orders and are the outcome of preceding systemic wars in the contingent domain of the System. To ensure the optimal balanced functioning of international orders these rules must necessarily take into account the different centrality (power positions) of states, that is, their contributions to the overall network's functioning; this means that the rules of the System contain privileges for dominant states. Because of differentiated development of nodes (differentiated growth of states) and the continuously increasing connectivity of the network, rules that apply to the interactions between nodes of the network eventually do not reflect the actual centrality of nodes and undermine the System's functionality. Increasingly obsolete rules and unfounded privileges of certain states contribute to the production of free energy.

Rules that apply to interactions between nodes in the network are only based on a snapshot of the centrality of these nodes during a relatively short critical period (systemic war).

360 Effective conflict prevention and control require us to focus on the deterministic domain of the System.

KEY WORDS *Deterministic domain, Contingent domain, Contingent latitude, Control, Prevention, Top-down and bottom-up perspective, Synchronization.*

Deterministic dynamics determine the latitude and the playing field of contingent dynamics in the System; interacting self-fulfilling prophecies synchronize contingent and deterministic dynamics. Effective conflict prevention and control require us to focus on the development of deterministic dynamics and properties of the System, and to complement these insights with analysis of contingent dynamics. An effective control system requires combining and integrating a top-down deterministic perspective and a bottom-up contingent perspective. The contingent perspective must focus on the crystallization, connectivity, and growth of underlying vulnerable issue clusters and accompanying tensions, and on how interacting self-fulfilling prophecies synchronize the deterministic and contingent domains.

361 The next systemic war will not constitute a phase transition.

KEY WORDS *Systemic war, Phase transition, Robustness, Fragility.*

The properties of the current first global order (begun in 1945) show that the next systemic war will not constitute a phase transition. The current order is not infinite robust and the System can still release tensions through non-systemic wars; the current order also is not infinite fragile. As explained, robustness and fragility are two sides of the same coin and infinite robustness and infinite fragility go hand in hand, and cause the anarchistic System to collapse.

These properties indicate that the System is not within reach of its critical connectivity threshold, and still can implement upgraded orders with improved robustness and structural stability, before eventually – at a later stage (in 2185, this study suggests) – collapsing

362 Empowerment of individuals and communities enables alternative organizational solutions to meet the demands of the second law of thermodynamics.

KEY WORDS *Empowerment, Communities, second law of thermodynamics, Free energy.*

Empowerment of individuals and communities refers to the ability of individuals and communities to organize themselves in network structures that lack central control, but that coordinate and integrate their interactions and activities through shared values and norms. These networks are better able to adjust to local conditions and events and leverage 'local' economies of scale and scope (synergies). Effective networks strike an optimal balance between shared requirements and local initiatives. Empowerment is enabled through the Internet, social media, communication technology, and global mobility.

I assume that these networks have superior performance compared to traditional hierarchical organizations (where, hierarchy is defined as central authority and not as integrated clusters (see also: (58)), and can evolve more flexibly, avoiding the buildup of tensions and jerky energy releases. If these assumptions are correct, it can be expected that the second law of thermodynamics – demanding lower energy-states for upgraded orders – will force the System to adopt orders that increasingly resemble networks.

363 Sub-optimality of state-structures, increasingly hybrid forms of warfare and the blurring of differences between internal and external security of states, point to the development of the global System towards a networks of communities.

KEY WORDS *System, second law of thermodynamics, States, Security, Suboptimal, Networks, Communities, Hybrid warfare.*

State organizations are the product of the first-finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945). During the development and unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles, a multitude ('hundreds') of divers and loosely connected units in Europe (in 1495), developed into a highly integrated anarchistic System with fractal structures consisting of 25-30 highly standardized states (in 1939). I argue that (four) systemic wars during the 1495-1945 period – that were integral parts of the first finite-time singularity dynamic – carved out this System with fractal (state) structures.

This process of integration (in Europe, the core of the anarchistic System), was accompanied by a simultaneous process of expansion of European states to non-core territories, that led to the implementation of state structures outside of the core. Over time (1495-1945) the state became the 'standard', and only 'legally' accepted structure in the System.

The state is a highly optimized structure, especially designed to meet the anarchistic and hostile conditions in Europe during the unfolding of the first finite-time singularity dynamic (1495-1945). States and anarchy are closely related, and coevolved.

However, following the dual phase transition (1939-1945, through the fourth systemic war, the Second World War), state-structures are increasingly challenged: In Europe, where state structures hinder the development and exploitation of economies of scope and scale (and efforts are underway to 'impose' a 'superstate'); but also in the Middle-East, Africa, and in Europe, where states 'collapse' (or regions seek autonomy), because the state is not (or less) effective in ensuring the fulfillment of basic requirements of their populations.

At the same time as the state becomes less effective, a trend towards increasing empowerment (also enabled by the Internet) of individuals and communities can be observed. Because of the empowerment of communities and individuals, warfare is increasingly 'hybrid' and involve not only states, but also 'populations', communities and individuals ('non-state-actors).

I assume, that the anarchistic System through the second finite-time singularity dynamic, which will also be accompanied by four accelerating cycles and will reach the critical connectivity threshold around 2185 (this study suggests), will step-by-step – 'systemic war by systemic war' – implement networks of communities, to ensure compliance of the global System with the demands of the second law of thermodynamics. States will become increasingly obsolete, and will increasingly hinder the (optimization of the) fulfillment of basic requirements by populations – and communities – in the anarchistic System. Networks of communities – networks of networks – can best balance 'local' (and community) requirements with (global) opportunities for economies of scale and scope.

I assume that the current struggles of the state to reach the next level of SIE, numerous state-collapses, the development of hybrid forms of warfare, and the blurring of differences between internal and external security of states/populations, are indicative for a trend towards (global) networks of communities. Hybrid wars, will carve out hybrid structures.

364 The ultimate phase transition of the second finite-time singularity dynamic will result in a non-anarchistic order at a global scale.

KEY WORDS *Second singularity dynamic, Critical connectivity threshold, Phase transition, second law of thermodynamics, Non-anarchistic structures, Network of communities.*

The current conditions of the System (1945-...) will also allow the first global order to become critical, produce a systemic war, and implement an upgraded order to ensure compliance with the second law of thermodynamics. World population growth, in combination with extended life expectancy and higher standards of living, suggest that a second finite-time singularity dynamic (begun in 1945) can be sustained at least until the early 22nd century.

The direction of development of the second finite-time singularity is similar to the direction of development of the first singularity dynamic (1495-1945) towards 'higher' levels of order and integration.

The second law of thermodynamics will impose upgraded orders on the System through successive systemic wars that produce increasing amounts of tensions as a consequence of the intrinsic incompatibility between connectivity and security in the anarchistic System. When the second finite-time singularity eventually reaches its critical connectivity threshold, it will produce a systemic war that will constitute a phase transition that results in a non-anarchistic order at a global scale in 2185 this study suggests). The exact form of this 'final' non-anarchistic order is also dependent on various contingent factors and conditions; in fact, the exact form does not matter for the System, as long as the demands of the second law of thermodynamics are met.

As explained, various indicators – including the (increasingly) hybrid structures of wars – suggest that the final non-anarchistic order probably resembles a network of communities, that are able to optimize local requirements, as well as 'global' economies of scale and scope.

365 Because the initial conditions of the first (1495-1945) and second (beginning in 1945) finite-time singularity dynamics differ in some respects, certain quantitative properties of both singularity dynamics could differ.

KEY WORDS *First singularity dynamic, Second singularity dynamic, Properties, Different initial conditions.*

Although the basic conditions and workings of both finite-time singularity dynamics are similar, and the same laws and deterministic principles apply, (particular) conditions and properties of the System at the start of respective singularity dynamics, differ in some important respects.

Contrary to the first order of the first finite-time singularity dynamic, the first order of the second finite-time singularity dynamic already has a significant level of order. Further research must determine to what extent the first finite-time singularity dynamic can be used as a reference for the second singularity, and if and to what degree similar war frequencies of orders of the first and second finite-time singularities imply similar levels of order. Further research must also determine if cycles of the first and second finite-time singularities accelerate with the same rates.

366 One to three non-systemic wars involving one or two Great Powers will bring the moving average of the sizes of five successive non-systemic wars of the first global order (begun in 1945) to the same level that typically produced systemic wars during the first finite-time singularity dynamic (1495-1945).

KEY WORDS *Critical fraction, Criticality, Moving average, War sizes, Prediction.*

The average sizes of non-systemic wars during high-connectivity regimes of international orders of the first finite-time singularity dynamic show that the System became critical and produced systemic wars when the moving average of the sizes of five non-systemic wars decreased to a value between 0.17 - 0.30, as shown in the table below.

'Critical fractions' of moving averages

International order		Critical fractions of moving averages of five successive non-systemic wars
1	1495-1618	0.18
2	1648-1792	0.30
3	1815-1914	0.19
4	1918-1939	0.17

Table 123 *This table shows the (critical) fractions of the moving averages of sizes of five successive non-systemic wars immediately before the System became critical during the first finite-time singularity dynamic.*

For the System to become critical again, the moving average of five successive non-systemic wars must come within a range of 0.17 - 0.30. For the moving average of the current order to reach this critical range, the System must produce one to three non-systemic wars in which one or two Great Powers participate. The war frequency of the current phase of the first global order suggest that the System will become critical around 2020.

367 A number of conditions could impact the development of a second finite-time singularity dynamic that started in 1945.

KEY WORDS *New actors, Impact.*

Although the basic dynamics and mechanisms of the first and second finite-time singularities are identical, there also are a number of differences, including: (1) the emergence of a new type of non-state actors that organize in global border-crossing communities, and (2) the emergence of new forms of organizational networks that seem better able to optimize certain properties and dynamics. These two developments are related. These 'new' non-state actors develop their own dynamics in the System, that however also impact on rivalries between states in the System, and by doing so, reinforce the System's dynamics. Their impact still is unclear.

368 Based on the development of the first finite-time singularity dynamic (1495-1945), it is possible to predict the properties of the second global order that will follow the fifth systemic war.

KEY WORDS *Singularity dynamic, Prediction, Properties Second global order, Sixth international order.*

Deterministic properties can be predicted accurately. Contingent properties can vary, but must in all cases meet the demands of the deterministic domain and the second law of thermodynamics. The second global order will have the following properties:

1 ***No phase transition***
The fifth systemic war will not constitute a phase transition. The second order is a next step in a longer-term SIE process. The System cannot establish a non-anarchistic order at a global level through a single systemic war, based on calculations of deterministic properties in the System. The fifth systemic war will be the first in a series that constitutes the second finite-time singularity dynamic that started in 1945, and also is accompanied by a number of accelerating cycles.

2 ***Robustness, fragility and structural stability***
The second global order will be more structurally stable and robust, but also more fragile than the preceding first global order. Its life span will be shorter than the life span of the first order (1945-2020, 75 years). Its war frequency will be lower.

3 ***Regional orders***
The second global order will include a number of regional orders that are integral parts of the global order, to meet the demands of the second law of

thermodynamics; these regional orders also contribute to a lower energy state of the System. Regional dedicated hierarchies could, for example, be established in the Middle and Far East, the European Union could be upgraded.

4 ***More network (community) structures***
The second global order will also include networks of global and regional communities that transcend the more formal orders referred to in (1) and (2), and that also contribute to a lower energy state of the new order.

5 ***State become increasingly obsolete***
States and their governments derive their legitimacy from their ability to contribute to the fulfillment of basic requirements, including security, of their populations. States have become increasingly vulnerable; this undermines their utility and legitimacy. The next global order will reflect that national defense by states is becoming an increasingly obsolete concept. This is the case for two reasons in particular: (1) given their function and organization, states are largely responsible for the free energy they unavoidably produce in anarchistic systems, and (2) because of the global range of destructive energy that can be deployed by states with aircraft and missiles, and by empowered individuals and communities by leveraging the Internet, social media, and global mobility. The vulnerability of states and governments is purposefully targeted by radical communities, and will be further magnified by the inability of states to respond proportionally to these threats.

369 The totality of war will reach a new level during the next systemic war.

KEY WORDS *Totality of war, Systemic war, Fifth systemic war, Warfare.*

During the unfolding of the first finite-time singularity dynamic (1495-1945) and beyond, when chaotic war dynamics resumed in 1989, the totality of war continuously increased.

Developments suggest that the 'totality' of the next (fifth) systemic war, will show a further increase in the resources that are mobilized to produce and deploy destructive energy.

During the early stages of the unfolding of the first finite-time singularity dynamic, wars were fought by armies of mercenaries and did not involve populations and all domains of societies. By the time the System produced the fourth systemic war, this had changed fundamentally: All domains of society were mobilized by then to produce and deploy large amounts of destructive energy for states to destroy issues and acquire favorable bargaining positions regarding the design and implementation of the next upgraded order.

The increasing totalization of war went hand in hand with a process of empowerment: For states to mobilize their populations and societies in order to produce and deploy ever-increasing levels of destructive energy, populations' active involvement and support were required.

Since the collapse of the Eastern hierarchy (1989) and the resumption of chaotic war dynamics (1989), changes in the nature of warfare can be observed that are also related to the process of (further) empowerment of populations and societies. Technological developments (the Internet, social media, and global mobility) are enablers of these dynamics. Whereas during the unfolding of the finite-time singularity dynamic, wars mostly involved states, wars now increasingly involve non-state actors (e.g., in Afghanistan, Iraq, Syria, Libya, and Yemen). There are now wars against people, wars amongst people, and wars involving cross-border communities and individuals.

During the next systemic wars, states will also be confronted with an enemy 'from within'. Globally connected communities and individuals will deploy destructive energy from within states to fight their own wars. The threat from within is organized in networks, as is increasingly the case in above mentioned wars. These developments will force states to also organize their destructive capabilities (armies, etc.) into networks to optimize the deployment of destructive energy.

The mobilizations of communities and individuals, the employment of networks 'from within', and in inter-state wars will cause (systemic) wars to become more total.

370 Radical and terrorist groups aim to undermine democratic states by setting self-destructive and self-reinforcing dynamics in motion 'from within'; states are not equipped to counter these threats without playing into the hands of these radical groups.

KEY WORDS *Radicalization, Terrorism, Enemy "from within', Self-reinforcement.*

Because destructive power can be deployed from great distances but also from within, national defense has become increasingly problematic. States cannot under all conditions ensure the absolute security of their populations. These shortcomings undermine the concept of the state that is still considered the optimal solution for the fulfillment of basic requirements of populations of states.

The state as we know it is based on a social contract between the government and its population. In exchange for the security governments provide to their populations, states have a monopoly on the deployment of destructive energy against potential threats to their populations and to the states themselves. However, if states do not honor their side of the contract, this monopoly will be challenged from within, and individuals and communities will organize their own security. By doing so they will infringe on the violence monopoly of states.

Radical groups that employ terrorist tactics target this social contract to undermine the fabric of the state and its society. They hope to set in motion a self-reinforcing dynamic in which increasing disorder and responses to increasing disorder by governments feed on each other. An enemy from within can lead to chaos from within, and ultimately, as developments in the Middle East show, to a state's collapse.

Democracies are especially vulnerable to radical groups and their terrorist tactics. The functioning of democracies is not only based on the social contract as such, but also on open societies that allow for unconstrained flows of information, people, and goods. These unconstrained flows ensure the democratic state's creativity, welfare, development, and adaptability. These unconstrained flows are based on trust and shared values and norms.

However, the unconstrained flows that provide democracies with their vitality can also be used by radical and terrorist groups to freely target populations and societies. In response to terrorist activity, states often feel forced to restrict flows, that – as explained – fulfill vital functions to democracies. By doing so, democratic states not only undermine their own functioning and legitimacy, but also their identities. These types of counter measures imposed by states play into the hands of radical and terrorist groups, and can set in motion a self-destructive dynamic.

The self-destructive dynamics that states and societies produce in response to threats from within resemble autoimmune diseases; the immune system that is supposed to protect an organism attacks healthy cells that pose no threat to the organism and, by doing so, undermine the system.

371 States are confronted with existential challenges.

KEY WORDS *States, State structures, SIE, Challenges, Collapse, Economies of scale and scope, Integration, Fragmentation.*

Typical properties of states, including exclusive control over well-defined territorial areas, centralized control, and a monopoly on the deployment of destructive energy against internal and external threats to security, are products of the finite-time singularity dynamic during the 1495-1945 period. During that period of time, the System developed from a loosely organized collection of diverse units into a highly optimized system of standardized states. The finite-time singularity dynamic produced these states, and states produced the singularity dynamic. States were optimal solutions for populations under the conditions that prevailed during the 1495-1945 period.

Because conditions have changed, states no longer are in all respects optimal solutions for the challenges populations presently have to confront.

As discussed, states are confronted with a number of existential challenges, including:

1) In Europe, the core of the System until 1939 and the 'birthplace' of the state, dedicated hierarchies have replaced anarchy (1945) and the state has – so to say – accomplished its task. As current struggles in the European Union also show, state-structures have become obstructions to the development and exploitation of the new synergies offered by a next level of SIE in Europe.

2) Outside of Europe, especially in the Middle East and Africa, state-structures were and are not always viable; that is, they are (for various reasons) not capable of ensuring the fulfillment of the basic requirements of their populations. This has resulted in the collapse of states and in efforts to replace states with alternative structures, often based on religious principles that are believed to produce better results.

3) States, especially in Europe, are confronted with threats from within, and states are not equipped to effectively confront these threats without causing 'collateral damage' that undermines their own legitimacy. States derive their legitimacy and existence from their abilities to ensure the security of their populations. Struggles of states with this primary responsibility suggest that state structures are no longer in all respects optimal.

These treats could cause fragmentation. Forces for fragmentation and integration continuously compete. This study shows that in the long term forces for integration (SIE) are stronger than forces for fragmentation: Integration has more to offer than fragmentation, assuming viable integrative structures can be found. The finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period, was in fact about 'finding' and perfecting the state as the optimal solution for challenges to populations in the core of the anarchistic System.

372 Accelerated integration as well as renationalization can relieve Europe from its current vulnerable 'stuck-in-the-middle' condition; in case of renationalization certain synergies cannot be developed and exploited, and the production of free energy (tensions) could resume. Increasing connectivity will push Europe (again) towards further integration.

KEY WORDS *Integration, Renationalization, European Union, Stuck in the middle, Re-activation, Security dilemma, Free energy, Systemic war.*

At the moment Europe is stuck in the middle; state-structures are partially dismantled, while integrative structures at a European level are not yet fully designed and implemented. As a consequence, individual states are constrained in their interactions, while Europe cannot adequately ensure an optimal internal balance or responses to external challenges and threats. Whereas Europe could and should be more than the sum of its parts, it now is less.

Europe's internal focus and political maneuvering further aggravate this condition.

In principle, two options are available to get out of this unsatisfactory 'worst-of-two-worlds' condition: accelerated integration or renationalization.

The question is what the effects of renationalization could be. Renationalization could result in the resumption of rivalries between European states, and even the re-activation of the security dilemma. I assume however that the current connectivity of European states is too high to produce non-systemic wars (release events), as was the case during the fourth relatively stable period (1918-1939) of the first finite-time singularity dynamic (1495-1945). I assume that the current 'order' in Europe is and stays 'infinite' robust, also in case of renationalization of states and re-activation of the security-dilemma. This infinite robustness of Europe however, implies that the free energy that builds up in Europe (as a consequence of renationbalization and a possible re-activation of the security dilemma), can only be released through systemic war; this is what the second law of thermodynamics will enforce.

However, there also is another scenario that could play out if states in Europe renationalize, assuming that the demands of the second law of thermodynamics are met. In this scenario, the global System becomes critical (as I expect to happen) and produces a systemic war that results in the implementation of an upgraded second global order to ensure compliance with the second law of thermodynamics. This global systemic war is then be used by European states to implement an upgraded version of the European order that can ensure internal balance and adequate responses to external threats during the second global order.

373 The global non-anarchistic System that eventually will emerge will consist of a 'network of networks'.

KEY WORDS *Second Singularity dynamic, second law of thermodynamics, Critical connectivity threshold, Network of networks.*

Assuming that the second finite-time singularity dynamic (begun in 1945) can sustain its development, it will ultimately reach the critical connectivity threshold and produce a phase transition through a systemic war. Before the threshold is reached, the System will have produced a number of accelerating cycles, as was the case for the first finite-time singularity dynamic (1495-1945).

When the second finite-time singularity dynamic reaches the critical connectivity threshold, the global anarchistic System will produce infinite amounts of free energy (tensions), and the relatively stable period (at that point in time) will have become infinitely robust and fragile. At that point the (global) anarchistic System can no longer implement yet another upgraded order that meets the demands of the second law of thermodynamics, and collapses; a response similar to the first finite-time singularity dynamic in 1939. Through a phase transition to a non-anarchistic configuration, the System will ensure that it meets the demands of the second law of thermodynamics.

The integrative structures that will be imposed will, I assume, not resemble a centralized government (like in the current state model), but will consist of a 'network of networks' that connect regional and global communities (including certain 'support facilities') in the System. These networks will function and operate on the basis of shared values and norms, and strike a balance between local requirements (like identities), and regional and global opportunities for economies of scale and scope.

The increasingly hybrid structure of wars, point to the network and community structures future wars will carve out in the System.

By utilizing parallel processing properties, networks can better develop and utilize synergies in the System, and can more effectively and efficiently distribute information, compared with centralized hierarchical organizations that are dependent on top-down control. The second law of thermodynamics will push the System in that direction, I assume, through a number of systemic wars that will be produced at an accelerating rate.

The global non-anarchistic System that will eventually emerge will resemble life forms, including in its security-arrangements that will have properties of immune systems at a conceptual level.

374 Wars are symptoms of the underlying deterministic dynamics of anarchistic systems; prevention and control of wars require measures that take into account the underlying deterministic properties and dynamics of the System.

KEY WORDS *Deterministic domain, Control, Prevention, War, second law of thermodynamics.*

Wars are the outcome of a simple unavoidable logic: energy obeys the second law of thermodynamics, including the free energy that is produced by anarchistic systems. Deterministic laws and principles cannot be ignored. The second law of thermodynamics applies to the free energy (tensions) produced by the System. Conflict prevention requires that *free energy production* is stopped, and/or that the *mechanisms* by which this energy is put to use are changed.

Free energy production – the productions of tensions in the System – is a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems. Free energy production can be reduced or prevented by: (1) avoiding a further increase in the connectivity (that is population growth) of the anarchistic System, (2) changing the notion of security that is inherent to anarchistic systems, or (3) replacing anarchy with a non-anarchistic system. This study shows that anarchy is replaced – and must be according to the second law of thermodynamics – when the anarchistic System reaches the critical connectivity threshold, and collapses as a consequence.

Changes in *mechanisms* that determine how free energy is put to work in anarchistic systems (typically by war) also provide clues to conflict prevention measures. Mechanisms that determine how free energy is put to work in anarchistic systems include the structure of decision-making processes and the connectivity of the System.

Decision-making dynamics in anarchistic systems are determined by (1) the nature of war decisions that qualify as 'binary decisions with externalities and thresholds,' implying that states constitute binary switches with two conditions: 'war' or 'no war'; and (2) the fact that these binary switches (states) form networks with their own typical dynamics, that depend on the level of their connectivity (low or high), and thresholds states apply concerning war decisions.

Stopping the production of free energy and changing the mechanisms that determine how free energy is put to work address underlying causes of the war dynamics of the System and go further than just combating symptoms. However, this study also suggest that these fundamental changes cannot be achieved by other means than systemic wars.

Through systemic wars upgraded orders are implemented step-by-step; each upgraded order builds on the arrangements of its predecessor. But – despite these 'efforts' of the System, that only provide temporary respite – it is just a matter of time before the anarchistic System collapses. When the anarchistic System collapses (when the critical connectivity threshold is reached) the System must implement a non-anarchistic order to ensure compliance with the second law of thermodynamics.

It must be kept in mind, that the finite-time singularity dynamic accompanied by four accelerating cycles, was an optimal solution of the System to accommodate and allow for the population growth the System experienced during the 1495-1945 period.

375 **A control system with the function to prevent and control wars requires an approach that combines a top-down deterministic perspective with a bottom-up contingent perspective, and that takes the interface between both domains into consideration.**

KEY WORDS *Control system, Top-down approach, Bottom-up approach, Interface, Interacting self-fulfilling prophecies, Contingent latitude.*

Wars are symptoms of dynamics intrinsic to anarchistic systems. As far as it is possible, for a control system to prevent and control wars in an anarchistic system, such a control system must combine a top-down deterministic perspective with a bottom-up contingent perspective, and also take the interface between these two domains of the System into consideration.

Deterministic properties and dynamics of the System include the main features of the finite-time singularity dynamics, like the timing, duration, and amount of destructive energy that must be deployed during systemic wars, and the robustness of relatively stable periods. These deterministic properties determine the latitude for contingent dynamics. Interacting self-fulfilling prophecies between states synchronize the dynamics in both domains, and can be considered an interface. The interface consists of attractors around which tensions crystallize; vulnerable issue clusters are the product of this interactive crystallization process. Attractors are issues that rival states and populations interactively create and use to justify the production and deployment of destructive energy.

To be able to predict wars, a prerequisite for prevention and control, the deterministic domain governed by a number of deterministic laws, the contingent domain in which change plays a dominant role within the latitude defined by the deterministic domain, and the interface between the two domains must be taken into account.

Given the nature of war dynamics in the System, the design and implementation of effective measures to prevent and control wars is problematic – 'impossible' – if the 'underlying' deterministic properties of the war dynamics are not incorporated in such a control system.

PART V

CONFRONTATION

Mankind must put an end to war before war puts an end to mankind

John F. Kennedy

Introduction

In this part, I confront historical research and generally accepted opinions regarding war dynamics and the development of the System with results from this study. Until now, any meaningful regularities were not identified in the war dynamics and development of the System, let alone in identifying the underlying dynamics and mechanisms that produce such regularities. This study now provides a framework or theory that addresses these shortcomings. Finally, we are able to understand the workings of the System, predict some of its dynamics, and identify clues to prevent wars and mitigate their effects.

The aims of the 'confrontation' are: (1) to test (as far as possible) some of the hypothesis and conclusions of my research, (2) to show and explain that historical research – unaware of the existence of a deterministic domain – exclusively focused on the causality of contingent and (often) unique historical events, unavoidably resulting in incomplete and incorrect conclusions, and (3) to provide some alternative explanations of historical events with help from the new insights this study provides.

I discuss the following studies (research):

1) *Coercion, Capital and European States, AD 990-1992*, by Charles Tilly (70);
2) *The Sovereign State and Its Competitors*, by Hendrik Spruyt (66);
3) *Politics Among Nations, The Struggle for Power and Peace*, by Hans Morgenthau (43);
4) *The Sleepwalkers: How Europe Went to War in 1914*, Christopher Clark (18)

Tilly and Spruyt, in particular, focus on the formation of the state and the conditions and mechanisms that produced these organizational arrangements. Both historians emphasize the impact of war on the formation of the state and observe that the state, state formation, war, and war dynamics are closely related phenomena. Despite this study results in (in some cases) fundamentally different explanations, Tilly's and Spruyt's studies are helpful in understanding the mechanisms that contributed to the war dynamics (the singularity dynamic) of the System during the period between 1495–1945.

As I mentioned previously, the four studies that I discuss in this part ('Confrontation') share the fact that their authors were unaware of the existence of an underlying deterministic domain that, to a high degree, determined and shaped the dynamics and events in the contingent domain. In my discussion of these studies, I point to these shortcomings, when they are evident. With this 'confrontation', I do not intend to re-write history. The evaluations that I conducted are, at this stage, still too superficial; more research is required. My aim is to test my own theory, and point to some obvious shortcomings that can now be identified in the studies I discuss, as well as in historical research methodology that led to these shortcomings.

1 Evaluating Coercion, Capital and European States, AD 990-1992 by Charles Tilly

1.1 Introduction

In the study *"Coercion, Capital, and European States, AD 990 - 1992"* (70), Tilly merged three of what he calls 'concerns': the history and dynamics of collective action, the process of urbanization, and the formation of national states. Tilly argues that states, and state formation, must be seen as efforts to "acquire the means of war," and that "... war and preparation for war, strongly affected the entire process of state formation."

Tilly observes that "States have been the world's largest and most powerful organizations for more than five thousand years. Let us define states as coercion-wielding organizations that are distinct from households and kinship groups and exercise clear priority in some respects over all organizations within substantial territories." "Only during the last few centuries have national states mapped most of the world into their own mutually exclusive territories, including colonies."

"States form systems to the extent that they interact, and to the degree that their interactions significantly affects each party's fate. Since states always grow out of competition for control of territory and population, they invariably appear in clusters, and usually form systems. The system of states that now prevails almost everywhere on earth took shape in Europe after AD 990, and then began extending its control far outside the (European) continent five centuries later. It eventually absorbed, eclipsed, or extinguished all its rivals..."

"Five hundred years ago, Europeans were busy creating a pair of arrangements that were the unique: first, a system of interconnected states linked by treaties, embassies, marriages, and extensive communication; second, declared wars fought by large, disciplined military forces and ended by formal peace settlements. They were entering a period in which the major realignments of boundaries and sovereigns throughout the continent occurred at the ends of wars, under the terms of agreements joined by multiple states."

"In Europe something resembling the state system we know today was taking shape. The participants, moreover, were increasingly not city-states, leagues, or empires, but national states: relatively autonomous, centralized, and differentiated organizations exerting close control over the population within several sharply bounded contiguous regions."

"(...) We can reasonably date the establishment of regular diplomatic missions within Europe to the fifteenth-century practice of Italian states." "With the institution of embassies came extended information-gathering, widened alliances, multilateral negotiations over royal marriages, greater investment of each individual state in the recognition of other states, and a generalization of war."

Tilly observes, "So natural do the rise of national states, the growth of national armies, and the long European hegemony appear, indeed, that scholars rarely ask why plausible alternatives to them – such as loosely-articulated regional empires that thrived in Asia, Africa and the Americas well past AD 990 – did not prevail in Europe. Surely part of the answer lies in the dialectic of cities and states that developed within a few hundred years after 990.

"For the coincidence of a dense, uneven urban network with a division into numerous well-defined and more or less independent states eventually set apart Europe from the rest of the world. Behind the changing geography of cities and states operated the dynamics of capital (whose preferred sphere was cities, and can be considered centers of creativity, innovation and wealth creation), and of coercion (which crystallized especially in states). Inquiries into the interplay between cities and states rapidly become investigations of capital and coercion."

Tilly introduces new insights into the process of (national) state formation in Europe. Contrary to other researchers and historians, Tilly "places the organization of coercion and preparation for war squarely in the middle of the analysis, arguing in its rasher moments that state structure appeared chiefly as a by-product of rulers' efforts to acquire the means of war; and second by insisting that relations among states, especially through war and preparation for war, strongly affected the entire process of state formation."

In this paragraph, I discuss the following subjects: state formation, the contribution of war to state formation, a dynamic Tilly called 'rhythms of war,' the development of Europe, from a collection of loose units, into a tightly knit Europe, and export of the state (outside Europe) through methods such as colonialism.

1.2 State formation

According to Tilly, "three different types of state have proliferated in various parts of Europe during major segments of the period since 990: tribute-taking empires; systems of fragmented sovereignty such as city-states and urban federations, and national states." Typically, "national states unite substantial military, extractive, administrative, and sometimes even distributive and productive organizations in a relatively coordinated central structure."

"The long survival and coexistence of all three types tells against any notion of European state formation as a single, linear process, or of the national state – which did, indeed, eventually prevail – as an inherently superior form of government." Tilly argues that national states stand "in between tribute-taking empires and city-states, built around war, state making, and extraction like other states, but compelled by bargaining over the subject population's cession of coercive means to invest heavy in protection, adjudication, and sometimes even production and distribution."

Sometime after 1490, alternative opportunities were foreclosed (*IP: another example of path dependence*) and Europeans "set off decisively toward the creation of a system consisting almost entirely of relatively autonomous national states." The same states, on the other hand, diminished in number and increased in area; "over the next four centuries, many war settlements and a few deliberate federations drastically reduced the number of European states. During the nineteenth century, the number stabilized."

Regarding the development of the number of European states (starting around 1490) depends, as Tilly puts it, 'on contestable decisions bearing on the very nature of the eras of states.' Tilly observes "no plausible set of definitions yields fewer than 80 distinct units or more than 500." Despite difficulties to accurately define 'units,' it was obvious that "Europe was beginning to consolidate into territorially distinct states organized around permanent military establishments, and military superiority was starting to give the larger states better changes of survival." In other words, size matters in an anarchistic system.

"Over the next four centuries, many war settlements and a few deliberate federations drastically reduced the number of European states. During the nineteenth century, the number stabilized." "Major consolidations occurred with the formation of the German Empire and the kingdom of Italy. By the start of 1890, the roster of states had declined to about 30, of which nine were members of the German Empire. At the end of 1918, the count stood at around 25 separate states. Although boundaries changed significantly with the settlements of World Wars I and II, the number and size of European states did not change dramatically during the twentieth century."

The dynamics Tilly described (not coincidentally) coincided with the unfolding of the singularity dynamic in 1495–1945. Tilly describes – what I – call the process of crystallization of units/states in the System in fractal structures; as discussed: eventually the size-distribution of states could be best described with a power-law. I argue that these fractal structures were over time carved out by fractal war activities during successive systemic wars. According to physical laws, free energy must be put to work to create more order and to minimize the production of free energy. In the System, free energy is put to work at the critical point through systemic wars. Order is achieved by introducing new organizational principles, but also by introducing physical structures (fractals) that minimize the production of free energy, and optimizes its employment (if required). In other words, fractal structures best support international orders in balancing state interests and avoiding the creation of tensions, and in distributing destructive energy during systemic wars..

Consistent with Tilly's observations, I also observed that the selection process, over time, became more limited in scope. Initially, selection was foremost a competition between diverse attributes of different organizational structures. Over time, however, competition became increasingly focused on specific attributes of these organizational structures, especially their potential to develop, produce, mobilize, and deploy destructive energy. This focus further fueled the singularity dynamic, and contributed to an increase in the level of totality in war.

1.3 The contribution of war to state formation and vice versa

According to Tilly, two factors account for the development of all European states in the direction of "greater concentration with respect to capital and coercion." First, "the continuous, aggressive competition for trade and territory among changing states of unequal size, which made war a driving force in European history." The second lies in "the processes by which states acquire and allocate the means of carrying on their major activities." Tilly describes, "the crucial means were especially coercive, the means of war." "Coercive means obviously played a part in war making (attacking external rivals), state making (attacking internal rivals), and protection (attacking the enemies of the state's clients)."

"The most powerful rulers in any particular region set the terms of war for all: smaller rulers faced a choice between accommodating themselves to the demands of powerful neighbors and putting exceptional efforts into preparations for war. War and preparations for war involved rulers in extracting the means of war from others who held the essential resource, such as men, arms, supplies, or money to buy them, and who were reluctant to surrender them without strong pressure or compensation. Within limits set by the demands and rewards of other states, extraction and struggle over the means of war created the central organizational structures of states."

Tilly explains why and how war further contributed to the selection of the state, as the preferred organizational structure of 'units:' "... the increasing scale of war and the knitting together of the European state system through commercial, military, and diplomatic interactions eventually gave the war making advantage to those states that could field great standing armies; states having access to a combination of large rural populations, capitalists, and relatively commercialized economies won out. They set the terms of war, and their form of state became the predominant one in Europe. Eventually European states converged on that form: the national state."

"Coupled with the continued buildup of the state's armed force, the disarmament of civilians enormously increased the ratio of coercive means in state hands to those at the disposal of domestic rivals or opponents of those currently holding state power."

"A ruler's creation of armed force generated durable state structure." "From AD 990 onward, major mobilizations for war provided the chief occasions on which states expanded, consolidated, and increased new forms of political organization."

"Why did wars occur at all? The central, tragic fact is simple: coercion works; those who apply substantial force to their fellows get compliance, and from that compliance draw the multiple advantages of money, goods, deference, access to pleasures denied to less powerful people. Europeans followed a standard war-provoking logic: everyone who controlled substantial coercive means tried to maintain a secure area within which he could enjoy the returns from coercion, plus a fortified buffer zone, possibly run at a loss, to protect the secure area."

"Police or their equivalent deployed force in the secure area, while armies patrolled the buffer zone and ventured outside it (…). When the operation succeeded for a while, the buffer zone turned into a secure area, which encouraged the wielder of coercion to acquire a new buffer zone surrounding the old. So long as adjacent powers were pursuing the same logic, war resulted."

Tilly also analyzes war data and observes, "over the long run, European wars became more lethal and less frequent." This statement is however not correct as this study shows; it is essential to distinguish between systemic and non-systemic wars. As I argue in this study, non-systemic wars became, on average, smaller in size and less frequent while, at the same time, systemic wars emerged at an accelerating frequency and with an accelerating strength (intensity). The System became more robust and fragile at the same time.

Typically, historians, like Tilly in this study, but also Levy (38), analyze war data on a 'century-by-century basis' (1600–1700, 1700–1800, etc.). As I explained this approach/perspective is fundamentally wrong for two reasons. First, because a finite-time singularity accompanied by four accelerating cycles shaped the war dynamics of the System during the period between 1495–1945, making a 'cycle' the appropriate unit of analysis. The second reason that Tilly et al.'s perspective is not correct is that these historians are unaware of the fundamental distinction between systemic and non-systemic wars. Systemic wars are not just scaled-up versions of non-systemic wars, but rather form a fundamentally different category in their own right, with a fundamentally different function (to design and implement upgraded orders).

Tilly also points to "…the heavy involvement of European states (which, from the sixteenth to the nineteenth century constituted almost all the world's great powers) in warfare, century after century." He also suggests that "preparation for war, paying for it, and mending its damage preoccupied rulers throughout the five centuries under scrutiny." "In the five centuries before 1500, furthermore, European states concentrated even more exclusively on the making of war. Over the millennium as a whole, war has been the dominant activity of European states."

"If war drove states, it did not exhaust their activity. On the contrary: as a by-product of preparations for war, rulers willy-nilly started activities and organizations that eventually took lives of their own: courts, treasures, systems of taxation, regional administrations, public assemblies, and much more."

"The tasks of fitting out armies and navies were not the only ones which resulted in an expanding governmental structure. No monarch could make war without securing the acquiescence of nearly all his subject population, and the active cooperation of at least a crucial few. Over and over, rulers sent troops to enforce the collection of tribute, taxes, and levies of men and materials."

Despite their intense war fighting activities before 1500, as Tilly describes, Europe at that stage did not constitute a coherent system. Tilly argues that, around 1500, a number of important transitions took place. As I explained, and consistent with assumptions made by Tilly et al., around 1500, Europe reached a certain degree of connectivity, became a system, and started producing a finite-time singularity.

Tilly argued that "… not long after 1495, Europeans had so far extended their military control that their system had become the great power system of the entire world". "By the end of the fifteenth century, then, the European state system had acquired a clear structure and membership. It was on its way, furthermore, to dominating the world."

From around 1500 onwards, "War wove the European network of national states, and preparation for war created the internal structures of the states within it. The years around 1500 were crucial." Warfare became more specialized and costlier, and "especially France and the Habsburg Empire, had the scale to absorb the increased costs, and took advantage of it." "The rivalry of France and Spain began to reverberate through European politics." "On a European scale, then, the late fifteenth century marked an important transition: as the large military states began to feel the stimulus of capitalist expansion, the advantages of the small mercantile states began to disappear."

Tilly also identifies some developments around 1500 that resulted in a change in the interactions and dynamics in the system that had emerged. These developments further strengthened the nation state as the most viable structure.

Italy in the 1490's shows the transitions taking place in Europe around that time. "They differed in bringing not just ambassadors, princes, and imperial forces, but large armies from the waxing national states across the Alps, into city-state Italy." "The French invasion of 1494 (of Italy) made the peninsula Europe's battleground, ended the round of small-scale wars among autonomous city-states… ." In fact, by competing for hegemony in Italy, the Northern states, forcibly integrated Italy into a larger system spanning much of Europe. "As the northern states generalized their wars and drew Italy into their struggles, war on land became more important, and the ability to field large armies more critical to a state's success."

Another transition concerns the organization and recruitment of armies: "From the fifteenth to seventeenth centuries – the critical period for European state formation – armies deployed through much of Europe consisted largely of mercenaries recruited by great lords and military entrepreneurs." Now a process was set in motion, in which these mercenary armies were gradually replaced by national armies. "The wars of the French Revolution and Empire capped the trend, and ended the dominance of mercenary armies," "by raising huge, effective armies chiefly from France's own expanding territory." "With a nation in arms, a state's extractive power rose enormously, as did the claims of citizens on their state."

The developments that Tilly describes are consistent with my own observations that over time, war became more total in the sense that states developed, mobilized, and deployed an increasing variety and increasing numbers of resources. Furthermore, the state had become the superior standard as competition increasingly focused on producing and mobilizing destructive power. However, states also had to balance the use and distribution of resources: "Whether they borrowed heavily or not, all rulers faced the problem of paying for their wars without destroying the ability of their sources to pay again in the future." Tilly points to what I define as the need for states to maintain a certain balance regarding the fulfillment of their basic requirements. War is not an end in itself, but just another means to fulfill basic requirements that are perceived to be, in certain respects, at risk or under threat. War itself is a risky endeavor. Its effectiveness is difficult to predict, and war efforts force states to temporarily divert scarce resources to these efforts at the cost of neglecting other vital requirements and losing internal balance.

For a long time, European states concentrated on war, leaving most activities to other organizations "just so long as those organizations yielded tribute at appropriate intervals." However, "as time went on, states took on activities, powers and commitments whose very support constrained them." This development further contributed to the 'totalizing' of war, by dedicating ever more resources to potential war.

"According to Tilly states developed the following activities initially: (1) *state making* ("attacking and checking competitors and challengers within the territory claimed by the state"), (2) *war making* ("attacking rivals outside the territory already claimed by the state"), and (3) *protection* ("attacking and checking rivals of the rulers' principal allies, whether inside or outside the state's claimed territory")."No state lasts long, however, that neglects a crucial fourth activity" (4) *extraction* ("drawing from its subject population the means of state making, war making, and protection"). Tilly further explains: "At the minimum, tribute-making states stayed close to this indispensable set of four activities, intervening in the lives of their nominal subjects chiefly to impose ruling-class power and to extract revenues. Beyond a certain scale, however, all states found themselves venturing into three other risky terrains": (1) *adjudication* ("authoritative settlement of disputes among members of the subject population"), (2);

distribution ("intervention in the allocation of goods among members of the subject population") and (3) *production* ("control of the creation and transformation of goods and services by members of the subject population").

"War making and state making reinforced each other, indeed remained practically indistinguishable until states began to form secure, recognized boundaries around substantial contiguous territories."

"As rulers drew more and more resources for war and other coercive enterprises from their local economies, the major classes within those economies successfully demanded more and more state intervention outside the realm of coercion and war." "Thus national standing armies, national states, and direct rule caused each other."

Increasingly states (also) provided identity' to its populations: "In one of their more self-conscious attempts to engineer state power, rulers frequently sought to homogenize their populations in the course of installing direct rule." "European states began forcing the choice between local and national loyalties during the eighteenth century." "War itself became a homogenizing experience, as soldiers and sailors represented the entire nation and the civilian population endured common privations and responsibilities."

"Struggle over the means of war produced state structures that no one had planned to create, or even particularly desired" … "organizations themselves developed interests, rights, perquisites, needs, and demands requiring attention on their own." "In similar ways, bureaucracies developed their own interests and power bases throughout Europe." "The state-transforming processes we have surveyed produced a surprising result: civilization of government."

1.4 'Rhythms of war'

Tilly observes that around 1500, "the increasingly connected European state system shifted to the rhythm of major wars." In the discussion that follows, Tilly "arbitrarily takes all wars in Levy's list during which great powers suffered at least 100.000 battle deaths." Because of their great impact on the System, Tilly specifically discusses the four wars that I defined as systemic: "The cruel Thirty Years' War locked the European state system in place." "(…) the end of the Thirty Years' War consolidated the European system of national states" (*IP: by introducing the sovereignty principle, defining a key-property of units of the system. This is part of a process of self-selection, as discussed*). "The Congress of Vienna (1815), ending the Napoleonic Wars, brought together representatives of all Europe's powers, not to mention many of its would-be powers." "In that settlement (IP: *Congress of Vienna*) and in the negotiations following World War I, the great powers came as close as they ever have to the deliberate collective mapping of the entire state system, right down to the boundaries, rulers, and constituents of individual states." "The settlements of World War I brought the last more or less general, simultaneous, and consensual redrawing of Europe's map."

Tilly's observations are consistent with my own regarding the development of the singularity dynamic and its impact on the structural stability of the System. During the time frame that Tilly examines – during the unfolding of the finite-time singularity dynamic (1495-1945) – Great Power status dynamics in Europe came eventually to a halt because Great Powers could 'permanently' embed their positions ('status') in the System; while at the same time the System reached and 'settled' into optimal (fractal) structures. Both these developments are closely related. This process of crystallization contributed to the (increasing) structural stability of the System, and its increasing robustness and fragility. The process of crystallization, as I denote it, was complete shortly before the collapse of the anarchistic System in 1939.

Tilly argues that this 'catalog' (i.e., the selection of wars with more than 100.000 battle deaths that I just mentioned) "gives an idea of the enlarging scale of war, and the increasing generality of peace settlements up to World

War I." It also suggests, according to Tilly, "... that with World War II the internationalization of conflicts burst the four-hundred-year-old system of peace settlements by general congresses." "Since that time, the standoff between the Soviet Union and the USA has greatly complicated the completion of any general peace settlement." (*This study was published in 1990*).

A couple of additional comments are useful here, based on the theory I developed in this study. Until now, the singularity dynamic and, as a consequence, various regularities in war dynamics were not identified. This explains why Tilly et al. analyzed war data on a century-by-century basis and did not recognize the fundamental differences between systemic and non-systemic wars. Tilly speaks of a 'rhythm of wars,' referring to a series of large-scale wars and peace settlements, without specifying this rhythm.

Tilly also observes that the Second World War (1939-1945), without recognizing that this fourth systemic war caused a dual phase transition, marks some fundamental changes in the System. Tilly observes that the Second World War caused an 'internationalization of conflicts' structurally involving non-European Great Powers and the fact that the 'system' of peace settlements had come to an end following the Second World War. The 'internationalization of conflicts' in the Second World War, I defined as the 'globalization of the System,' which is the moment other non-European Great Powers became an integral part of a global system.

As I explained the Second World War (the fourth systemic war, 1939-1945) in fact constituted a 'dual' phase transition: this dual phase transition resulted in the simultaneous implementation of two dedicated hierarchies in Europe – the core of the System – and first global order at a (now) global scale of the System. This dual phase transition was the outcome of the finite-time singularity dynamic accompanied by four accelerating cycles during the 1495-1945 period; the finite-time singularity developed on two 'lines' (dimensions): integration in Europe, the core of the System and expansion outside Europe.

In this respect, Tilly also observes, "From World War I onward, indeed, it becomes increasingly difficult to separate the European system from the world system of states that was forming rapidly." A number of observations that I present in this study are not new and were also recognized by historians. However, historians and social scientists were not able to place these observations in perspective and identify their relationships. This is now possible with the framework that I present in this study. It also has become evident that, contrary to what historians and social scientists believed, the System is a highly deterministic system.

The change in 'peace-settlement-dynamics,' Tilly mentions, also points to a fundamental change in dynamics of the System as they relate to the phase transition the System experienced. Tilly attributed this change (interruption) to the standoff between the Soviet Union and the United States. Tilly implicitly recognized, in my terminology, that the intense rivalry between these two 'super powers' contributed to a distortion in war dynamics. The question is, if such a 'peace-settlement-dynamic,' as was in place during the singularity dynamic (1495-1945), will resume now the current System has resumed chaotic non-systemic war dynamics, war dynamics that could well be an integral part of a next singularity dynamic that is now gaining momentum.

Tilly observes that, "The cracks in World War I's settlements, indeed, forecast the fissures that opened up at the end of World War II. By that time the world-wide reach of the formerly European state system, and the emergence of such geographically and politically eccentric powers as Japan and the United States put great stress on a set of relations that had worked more or less well for four centuries." This observation can now be put into perspective as well. These developments are closely related to the process of expansion – the second dimension – of the finite-time singularity dynamic (1495-1945).

1.5 Toward a 'tightly knit' Europe

Tilly shows that, with the help of two diagrams (one concerning joint involvement of European states in Great Power wars during 1496–1514, the other for the period between 1656–1674), that the "European state system had become more tightly knit" over time, and that the system "had shifted decisively northward, and had thereby lost its Italian focus." "Although the relative power and centrality of the participants altered considerably during the next two centuries, the map for the later seventeenth century shows us something like the structure that prevailed into our own time."

I consider Tilly's observations further 'proof' for the increasing permanence of the organizational (status hierarchy) and physical structures (state structures) during the unfolding of the finite-time singularity dynamic (1495-1945). This study shows that the consolidation of the network of 'joint involvement of European states in Great Powers wars' over time, as observed by Tilly, and the simultaneous decrease in Great Power status dynamics, and the crystallizing of geopolitical structures (states) in Europe toward fractal structures, constitute mutually reinforcing and coevolving processes.

1.6 Exporting the state, the state becomes the standard

Tilly observes, "During the last five hundred years, then, three striking things have occurred. First, almost all of Europe has formed into national states with well-defined boundaries and mutual relations. Second, the European system has spread to virtually the entire world. Third, other states, acting in concert, have exerted a growing influence over the organization and territory of new states. The three changes link closely, since Europe's leading states actively spread the system by colonization, conquest, and penetration of non-European states. The creation first of the League of Nations, then of the United Nations, simply ratified and rationalized the organization of all earth's people into a single state system."

"Note the meaning of these changes. On the average state formation moved from relatively 'internal' to a strongly 'external' process. War has weighed heavily on the formation of states throughout the history we have been surveying; to that extent the process has always been external. Nonetheless the further we go back in time the more we see rulers and would-be rulers struggle to tame the populations within the territories they nominally control, fight off armed rivals within those territories, conquer adjacent lands and peoples, and build up their own monopolies of force. Thus we see them inadvertently constructing states whose structures bear the marks of the struggles and bargains that brought them into being. Conversely, as we move forward in time we witness the increasing salience of concerts among states for the fate of any particular state - at least until World War II."

"Over the last three centuries, compacts of powerful states have increasingly narrowed the limits within which any national struggle for power occurred. They have done so through imposition of international war settlements, organization of colonies, diffusion of standard models for armies, bureaucracies and other elements of the state apparatus, creation of international organizations charged with tending the state system, collective guarantee of national borders, and intervention to maintain domestic order. That narrowing restricted the alternative paths of state formation. Throughout the world state formation converged on the more or less deliberate construction of national states – not empires, not city-states, not federations, but national states – according to models offered, subsidized, and enforced by the great powers." "Once the national state dominated Europe and parts of the world settled chiefly by Europeans, it served as the template for state formation everywhere." "National states won out in the world as a whole because they first won out in Europe, whose states then acted to reproduce themselves." According to Tilly, "European states held political control over about 7 percent of the earth's land in 1500, 35 percent in 1800, and 84 percent in 1914. That expansion in itself facilitated the multiplication of national states throughout the world."

Tilly's observation that "on the average state formation moved from relatively 'internal' to a strongly 'external' process" also seems the case for the core of the System (Europe) as such: initially the finite-time singularity dynamic (1495-1945) was one-dimensional in nature, in the sense that it only constituted a process of integration (in Europe), at a later stage, the singularity dynamic increasingly developed a second dimension: expansion of European states outside Europe.

2 Evaluating "The Sovereign State and Its Competitors" by Hendrik Spruyt

2.1 Introduction

Spruyt describes the aim of his book "... to explain how the elements that constitute the international system change over time" (66) Spruyt further sought "to demonstrate how international relations are influenced by the character of the system's constitutive elements." It is useful to challenge my theory with historical studies (including Tilly's and Spruyt's) as this forces me to address certain questions and research issues. On the other hand, these 'confrontations', which are still superficial, also make it possible to start identifying shortcomings in historical research and social research methodology. In this paragraph, I discuss some of Spruyt's observations with a focus on Spruyt's 'model of change' and the 'levels of change' he distinguishes.

2.2 The state and the System

The following observations give an impression of Spruyt's line of thought. In the next two paragraphs, I discuss the model of change that Spruyt developed and the mechanisms of change that Spruyt distinguishes.

Tilly explains: "The question of the origins of the state needs both a domestic and international explanation." "The evolution of the state and the development of a state system were mutually reinforcing processes." "On the one hand, the emergence of sovereign states had direct consequences for the other types of institutional arrangements in the system. The system selected out those types of units that were, competitively speaking, less efficient. In other words, the competitive nature of the system determined the nature of the constitutive units. At the same time, sovereign states preferred similar modes of organization in their environment. Actors intentionally created a system of sovereign, territorial states. They preferred a system that divided the sphere of cultural and economic interaction into territorial parcels with clear hierarchical authorities."

"The entire process can thus be seen in micro-macro or agent-structural terms. In the first place the variety of units form the elements of a system. Because of competitive pressure between these dislike units, and through mutual empowerment as well as individuals' choices, the system is gradually transformed into a network of similar actors. At that point the system imposes structural limits on the type of units that are possible and will be recognized by the other actors as legitimate forms of organization in international politics. With that in mind, we might sensibly speculate on the development of the state in the future."

In relation to the 'ability to wage war' of units in the System, Spruyt argues, "I have advanced the argument that the ability to wage war was a function of institutional arrangements. Organizational types that were fraught with freeriding and factionalism, that had problems rationalizing their economies and reducing transaction costs – in short, those that could not make the transition to consolidated national economies – were less effective and less efficient in mobilizing resources than sovereign states." "Sovereign authority proved to be more adept at preventing freeriding, standardizing weights and coinage, and establishing uniform adjudication. Equally important were the abilities of sovereign actors to coordinate their interactions with one another... States thus increasingly only recognized similar units (*IP: process of self-selection*) as legitimate actors in international relations."

"The ability to wage war operated as an intermediate cause of selection but was ultimately propelled by the consequences of particular institutional logics." "Selection was thus partially driven by competitive efficiency. It also advanced, however, by the process of mutual empowerment. Sovereign actors only recognized particular types of actors as legitimate players in the international system."

2.3 Spruyt's change model

In this paragraph, I discuss some elements of Spruyt's 'model of change.'

Spruyt distinguishes between three levels of change in international relations, namely (1) interaction change, (2) rank order change, and (3) change in the constitutive units. Spruyt explained that 'interaction change,' the change of diplomatic practices, is the most susceptible to individual decision making. Such practices are influenced by the presence of particular decision makers and by specific strategic choices. Spruyt's second level of change concerns 'shifts in the distribution of capabilities. 'Spruyt observes that "this type of change occurs less frequently. Changes in relative powers, occur, by some accounts, every century or century and a half. Such changes might correspond with periodic cycles in the economy."

The third and final level of change that Spruyt introduces concerns 'unit change.' Unit change, for example, describes the change from city-states to empires or from empires to feudal organizations and occurs least often. According to Spruyt, "When a particular type of unit comes to dominate the international system, it transforms the deep structure of the system." Spruyt argues "that a change in the constitutive units of the system (*IP: 'third level change'*) is only likely to occur after a broad exogenous change, or an environmental shock." "Such an exogenous change will lead to political and social realignments," and typically, "... actors choose to create institutions that meet their material interests and ideological perspectives." "A change in the constitutive elements of the system means a change in the structure of the system." However, Spruyt also explains that "the subsequent viability of institutions is constrained by their relative competitiveness." Spruyt argues "that broad-based external change has a variety of internal repercussions. In response to such an external change, new political coalitions will form based on material interests and shared conceptual frameworks. The expansion of trade was the critical external change that set this process in motion during the High Middle Ages." "An external change, a change in the overall milieu in which that society is placed, will lead to a shift in the relative power of social and political actors." "Actors will seek to capitalize on their improved relative position and change the existing political institutions."

Spruyt argues "that the economic transformation of the Late Middle Ages inspired individuals to create new forms of organization in Western Europe." "... all cued in to the new market opportunities created by the transition from local in-kind trade to long-distance monetized commerce." "Universalist empire, Roman theocracy, and feudalism gave way to the sovereign, territorial state, the city-league, and the city-state. These new institutional forms differed from each other in their degree of internal hierarchy and in whether or not their authority was demarcated by territorial parameters."

Spruyt argues that 'unit type' (also) influences international relations. "Historically, the establishment of a state system led to a re-categorization of who was entitled to exercise the means of violence." "The state system has led to a specific categorization of what is to count as internal or external violence and who may exercise such violence. The state claims a domestic and external monopoly of force. As a consequence, non-state actors are stripped of coercive means..."

"My discussion ends at about the time the Peace of Westphalia (1648) which formally acknowledged a system of sovereign states. This is not to say that the process of eliminating alternatives to states had been completed by then. But it did indicate that the variety in the types of units that existed in the Late Middle Ages was gradually being reduced, until later only a system of states remained."

Spruyt explains, "... it was the concept of sovereignty that altered the structure of the international system by basing political authority on the principle of territorial exclusivity. The modern state is based on these two key elements, internal hierarchy and external autonomy, which emerged for the first time in the Late Middle Ages."

This study shows that Spruyt's 'model of change' and the categorization he introduces are not correct or even relevant. The changes that Spruyt distinguishes mostly do not impact on the System's dynamics and development. As far as there is an impact (unit change, level three), the mechanisms that are at play are fundamentally different, as this study shows. The very regular and deterministic unfolding and development of the singularity dynamic during the period between 1495–1945 shows that the changes Spruyt distinguishes do not have a significant impact on the dynamics and development of the System during that period. What happened 'in' and 'with' the System does not qualify as unit change as defined by Spruyt.

Through the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) change, (the implementation of upgraded orders) was forced upon the System, and states constituting the System, to ensure compliance of the System with the second law of thermodynamics. It is however important to point out that, on the one hand, the singularity dynamic was about change while on the other hand, the singularity dynamic showed strong continuity of certain dynamics and processes in the System as well. An example of this is the consistent and highly accurate unfolding of the singularity dynamic during its life span (1495–1945). This consistency can already be observed in the early stages of the singularity dynamic even though at that stage, the state still had some competitors. The singularity dynamic is not produced by states, but its dynamic and its consistent unfolding are contained in the structure of decision-making processes of units (that may or may not be states) that make up the System. The structure of these decision-making processes has not changed since the inception of the System and the singularity dynamic around 1495; otherwise, such a consistency could not be achieved. The war logic of the anarchistic System is contained in the structure of decision-making processes of units regarding war. I explained that these decision-making processes qualify as 'binary decisions with externalities and thresholds,' and are the heart and core of the singularity dynamic.

This study shows that in fact the System and its dynamics and (direction of) development are highly deterministic in nature, now that the existence of a deterministic domain and its impact is revealed, it becomes evident that a model of change should be based on the dynamics and properties of the 'underlying' deterministic domain. The deterministic domain determines and shapes the dynamics and development of the System; contingent dynamics (events, changes, etc.) do not have the decisive impacts historians attribute to them.

Thus, my study leads to a fundamentally different model of change, including what change is and what change really matters. I presented such a model in part II and III of this study.

I now continue discussing Spruyt's observations. Regarding level two change, Spruyt mentions 'changes of relative power' as a factor affecting change and continuity. It is, however, not clear how 'changes in relative power' and their impact must be understood based on the insights that Spruyt provides. Spruyt's observations and general notions regarding changes in capabilities do not match with my own findings discussed in this study. I consider 'status dynamics of Great Powers' (based on Levy's dataset) as 'changes in relative power' of states, as meant by Spruyt. However, Great Power status dynamics typically occur during relatively stable periods, and are 'confirmed' - put into effect - during systemic wars that follow when 'new' Great Powers have the opportunity to anchor their newly acquired dominant positions in upgraded orders that will be designed and implemented through these systemic wars. Spruyt's observation, on the other hand, that "changes in relative powers, occur, by some accounts, every century or century and a half," is not a correct and accurate observation. Apart from the fact that their number decreases linearly when cycles are considered as the unit of analysis, the lifespans of successive relatively stable periods, during which these status changes typically take place, shorten at an accelerating rate.

Furthermore, there also is no correlation between "periodic cycles in the economy" (Kondratieff cycles) and changes in relative power, as I showed.

Finally, in this paragraph, I comment on Spruyt's observation that: "... a change in the constitutive units of the system is only likely to occur after a broad exogenous change, or an environmental shock." According to Spruyt, regarding the co-evolutionary development of the state and the System, "the expansion of trade was the critical external change that set this process in motion during the High Middle Ages." Although it is to a certain extent a matter of definition, if a certain development or shock must be considered an integral part of the dynamics of a system or an external shock, 'unit change' is an integral part of the core dynamics of the System, as this study shows. The co-evolutionary development of the state and successive international orders were shaped by two closely related mechanisms (principles) intrinsic to the System's dynamics, namely selection and self-organization, which pushed the System and states to the next levels of social integration.

2.4 Mechanisms of change

My study confirms Spruyt's observation that: "The cause of evolutionary progress in society lies in the increase in dynamic density - the total volume of transactions and communications." However, Spruyt does not elaborate further on this assumption. Regarding 'unit change', the most fundamental level of change according to Spruyt is that such a "scheme does not explain why such transformations occur infrequently or how such changes might look when they occur. Here the punctuated equilibrium model can be of some use, proposed by Gould." "In Gould's view, change can be dramatic and very quick. It takes the form of 'punctuated equilibrium': a dramatic shift along several dimensions simultaneously in response to a powerful environmental change."

"Stages of relative tranquility are interrupted by sudden and dramatic changes. Such broad exogenous change – punctuation – will lead to a flurry of radically new forms. In the long run, some of these forms may die out and a period of relative tranquility will ensue - a period of relative equilibrium. Whatever forms survive are not explained by reference to the types preceding the exogenous shock but by reference to the new environment and the now simultaneously existing forms which emerged after the shock." Gould presents a two-staged nature of evolution.

According to Spruyt, "Historical analysis indicates that institutional evolution proceeds in two stages... in the first stage a dramatic change in the overall environment leads to new political coalitions. Such coalitions will favor institutional arrangements that correspond to the coalitions ideological preferences and material interests. In the second stage the different types of institutions exert competitive pressure on each other, and particular arrangements will emerge as more effective and more efficient than others. Some forms of organization are also more compatible with others and hence become preferred systems of rule." "The dynamic of competitive advantage selected out those units that were less effective and less efficient than others."

In relation to state formation, Spruyt applies this two-stage model as follows: "The interaction between internal and external spheres is a two-staged process. At first, changes in the external milieu lead to domestic shifts in relative power between social and political actors. Those actors then realign to form new types of institutions. The new institutions then become part of the external environment... So in the second stage of social evolution, the internal changes of units alter the external environment in which other actors operate." "Institutional change will occur through a twofold process: a stage of institutional emergence and a subsequent stage of systemic selection."

Spruyt also points to 'inertia' in institutions that hampers change. This 'inertia' could explain why unit changes occur infrequently. According to Spruyt, "there are good reasons why actors do not redesign institutions unless conditions force them to do so. Transaction costs, set belief systems, and standard operating procedures mitigate against frequent overhaul. Moreover, given the fact that institutions reflect a particular distribution of power, such changes are unlikely to occur without fundamental shifts in that distribution. Once one form has established itself as dominant, relative stability in institutional types should follow. There is a certain path dependency in institutional design."

According to Spruyt, "Selection in international politics occurs basically through three mechanisms" through selection, mutual empowerment, and deliberate mimicry and exit. I elaborate on the last two mechanisms. Spruyt observes, "Selection of particular types of units thus also proceeds by empowerment. International actors determine who is to count as a legitimate international participant." Spruyt explains the effect of 'mutual empowerment' as follows, "... agents that make up the state system thus create a particular structure of inter-unit behavior. The very fact that some institutions are empowered as states, whereas others are denied that status, demonstrates how constraints have been placed on the subsequent choices of social actors." Pointing to the mutual advantages of standardization, Spruyt explains, "... because of their territorial character, states were compatible with one another. Their respective jurisdictions could be precisely specified through agreement on fixed borders. So not only could sovereigns speak on behalf of their subjects, they could also precisely specify who their subjects were."

"Sovereignty also spread by mutual recognition." "Here social selection differs from the unintentional biological process. Unlike what happens in natural selection, individuals create their own environment by preferring and tolerating only certain types of institutions. Sovereign, territorial actors had reasons to prefer similar systems of rule elsewhere."

I also elaborate on a third mechanism of change that Spruyt distinguishes. "Selection also occurs by deliberate mimicry and exit. Political elites copy institutional forms that they perceive as successful. At the same time, social groups switch their allegiance to those types of organization that better meet their interests." Spruyt explains that 'intentionality' during the first 'variation' phase of evolution is a critical difference between social and biological evolution. Biological organisms mutate at random, social groups may intentionally form political coalitions to deal with particular environmental constraints.

This study shows that Spruyt's framework needs adjustment. My first comment concerns Spruyt's observation that institutional evolution proceeds via two stages. The second comment focuses on the degree of control that Spruyt (and other historians and social scientists) ascribe to ourselves regarding war the dynamics and development of the System. I do however not comment on Spruyt's observations that change occurs infrequently; as is extensively discussed elsewhere in this study change occurs very regularly in the System.

Spruyt suggests that institutional evolution proceeds through two stages. In the first stage, a dramatic change in the overall environment leads to new political coalitions (...). In the second stage, "different types of institutions exert competitive pressure on each other, and particular arrangements will emerge as more effective and more efficient than others."

This study shows that the System, including states and successive international orders, do not change sequentially; it is a co-evolutionary process, in which cause and effect are closely intertwined. Spruyt's observation that new political coalitions are produced in response to "dramatic change in the overall environment' also is not correct: Change of and in the System is generated by dynamics intrinsic to the System, as I discussed previously. I argue that new coalitions (institutions) that are introduced immediately following a change (assuming this is the correct presentation of affairs) are already partial results of selection forces at work and also cannot be separated from the 'building blocks' (e.g., cultural elements, knowledge, and experience) that are preserved in the system and 'survived' previous change(s). These 'building blocks' - components - are remnants of previous and now partly outdated 'choices' of the System. The design process of a new international order that typically unfolds during systemic wars show how change, specifically a change of order, is accomplished in the System; systemic wars consist of three 'processes' that unfold more or less simultaneously.

The first process concerns the destruction of dysfunctional issues and tensions that have accumulated in the System. What exactly is considered dysfunctional is decided by dominant powers, that are in a position to achieve their destruction; power is influence. The second process concerns the design of the new order. A state's contribution to the process of destruction also determines its position when bargains are made pertaining to what the arrangements of the upgraded international order will be, and to what extent a state can force its preferred arrangements (privileges embedded in the upgraded order) on other states. The third process concerns implementation. During the implementation process, states, especially Great Powers, ensure that arrangements that are agreed upon are implemented accordingly; this also is a matter of power and influence.

My second comment concerns the 'control' Spruyt (and other historians and social scientists) assume we have. Although social groups may intentionally form political coalitions, as argued by Spruyt, he overestimates the control of so-called deliberate human decisions regarding the dynamics and development of the System. Indeed, institutions reflect a particular distribution of power, but the timing of institutional change, its direction of development, how the System changes, etc. is a highly deterministic dynamic produced by the System and enforced on so-called decision makers that do not have much to decide about. The unfolding of the singularity dynamic shows that we are to a high degree controlled by the self-organized deterministic singularity dynamic. This study shows that the singularity dynamic runs its own course despite all kinds of dynamics and changes that we think we control. As far as we control decisions or changes, they are often not relevant, or not more than an illusion. Often 'decisions' are only unavoidable responses to 'choices' the deterministic dynamics impose on decision-makers.

The dominance of the singularity dynamic, in particular its accurate unfolding and clear direction of development, raises the fundamental question of what our freedom of choice actually constitutes. Does freedom of action actually exist, and does what we define as 'freedom of action' actually matter?

The accurate timing of the four systemic wars that the System produced during the period 1495–1945 shows that war decisions are until now 'unknowingly' forced upon decision makers of states. Through a multitude of 'micro-interactions' (interactions between states), we unknowingly produced a self-organized macro-dynamic (the singularity dynamic) that then set the stage for the micro-dynamics that produced it in the first place, thereby increasingly determining and shaping our decisions regarding these micro-dynamics.

During 1495–1945, the System qualifies as a war trap that we (until now) unknowingly created and maintained. Despite the deterministic nature of some key properties of the System and its dynamics, we still attribute causes and effects to deliberate choices decision makers are believed to make.

This study should make us aware that much historical research and 'history' that is presented to us, actually is not complete and/or accurate; it is based on fundamentally wrong assumptions. We were and are not 'masters' of our own destinies, as we assumed until now and have been misled to believe. Our ability for collective self-illusion led us to believe that we controlled and shaped the System of which we are integral parts. This study shows that decisions we made (and still make) are more often than not just efforts in hindsight to justify and give meaning to 'processes' that are already set in motion and we do not control.

3 Evaluating "Politics Among Nations, The Struggle for Power and Peace" by Hans Morgenthau

3.1 Introduction

Morgenthau, Kissinger et al. are representatives of the so-called school of 'Political Realism' (43). Political Realism does not leave much doubt about what international politics are about: Power. Political Realism is a highly prescriptive doctrine for decision makers in states, providing dogmas and 'instructions' to ensure survival of states in an anarchistic system.

In this paragraph, I argue that the School of Political Realism is the product of the anarchistic System and of the finite-time singularity which was accompanied by four accelerating cycles during the period of 1495–1945, and vice versa. During this period, the 'Realist' school provided and still provides the 'scientific' justification and dogmas for state decision makers to engage in ever increasing intense wars.

This study, which makes the observation that war dynamics of the System are in fact deterministic in nature, makes us aware of a paradox that was until now not identified: On the one hand, wars are deterministic in nature, on the other hand, wars also are the outcome of deliberate human decisions. The question is how these contradictory properties can be reconciled, and if in fact his is an accurate representation of the dynamics and interactions in the System.

Wars do not just happen; armies do not just start marching without extensive preparation (let alone in the right direction). War-fighting requires the development, the production and deployment of destructive energy, and the mobilization of societies to achieve this. How and by what mechanisms does the System ensure that states make the 'right' war decisions at exactly the right time?

I argue that the School of Political Realism provides those mechanisms. It provides us with the decision rules to obey and the dogmas that produced the finite-time singularity dynamic (1495-1945).

Application of dogmas and 'rules' of the School of 'Political Realism' produce interacting self-fulfilling prophecies between states that in fact constitute an interface between the deterministic and contingent domain of the System. This mechanism (of interacting self-fulfilling prophecies) is closely related to the security dilemma that is inherent to anarchistic systems.

Contrary to what we believe and want to believe, war decisions do not qualify as 'free will' and do not qualify as examples of 'freedom of choice.' War decisions can be better qualified as self-organized mass-deception that is accomplished through these interacting self-fulfilling prophecies. The name 'School of Political Realism' could not be more appropriate since Political Realism provides us with a collective ability to create our own realities. By producing our own 'realties' through the application of dogmas and rules related to the School of Political Realism, Political Realism never disappoints.

The consistent unfolding of the finite-time singularity dynamic shows that this logic already existed well before the 'School of Political Realism' was formally introduced. The Realism logic, and the mechanisms it created and employed, are integral and necessary components of the singularity dynamic. Whereas political doctrines (fascism, communism, etc.) are instrumental in mass mobilizations—and 'invented' for that reason—Political Realism is instrumental in providing timely war preparations and decisions, which tied together with political ideologies, justifies the deployment of ever increasing levels of destructive energy, as was required for the unfolding of the finite-time singularity dynamic.

In this chapter, I discuss the following subjects: (1) the deterministic nature of war dynamics, and consistency in war decision making during the unfolding of the singularity dynamic in 1495–1945, (2) a number of key assumptions and dogmas of the School of Political Realism, and (3) mechanisms that ensure synchronization of the dynamics in the deterministic and contingent domain of the System.

3.2 Consistency in decision making and resulting determinism

As discussed in previous chapters, the singularity dynamic, its components (cycles, relatively stable periods, systemic wars) and their properties (e.g., the timing, duration, and intensity of systemic wars; the number of non-systemic wars the International System produced during successive relatively stable periods) developed deterministically and highly regularly during the period 1495–1945.

At the heart of the war dynamics of the System are human decisions to engage or not engage in war. Wars do and cannot just happen; instead, they require extensive planning, preparation and consideration. War decisions qualify as 'binary decisions with externalities and thresholds.' The connectivity and thresholds of the network of decision makers of states (and their issues) determine the size and frequency of war-cascades the System produces.

The accurate unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles shows that the nature of decision making and how these decisions are connected in a network, have not changed over time. The consistency of the unfolding of the finite-time singularity also shows that war decisions – how they were made and interacted, – were not dependent on the organizational structures of the units (e.g., states) making these decisions.

3.3 Key assumptions of the School of Political Realism

Despite the fact that Morgenthau's book "*Politics Among Nations, The Struggle for Power and Peace*" is somewhat dated, the ideas and theories he proposes still dominate decision making in international politics today. In this paragraph, I present some of the assumptions and dogmas of Political Realism.

It was Morgenthau's conviction that, beneath the rapid succession of events, certain basic characteristics of international politics remained, that is essential to understanding the "ebb and flow" of contemporary international life.

In *Politics Among Nations, The Struggle for Power and Peace*, Morgenthau purports to present a theory of international politics. The purpose of this theory is according to Morgenthau "to bring order and meaning to a mass of phenomena that without it would remain disconnected and unintelligible."

The shortcomings in the Realists' line of thought are now easy to spot. Realists – and all decisions makers of states show(ed) to be Realists – unknowingly(?), but effectively, leveraged interacting self-fulfilling prophecies it that then determined their inescapable decisions.

Morgenthau explains, "The issue this theory raises concerns the nature of all politics. The history of modern political thought is the story of a contest between two schools that differ fundamentally in their conceptions of the nature of man, society, and politics. One believes that a rational and moral political order, derived from universally valid abstract principles, can be achieved here and now. It assumes the essential goodness and infinite malleability of human nature, and blames the failure of the social order to measure up to the rational standards on lack of knowledge and understanding, obsolescent social institutions, or the depravity of certain isolated individuals or groups. It trusts in education, reform, and the sporadic use of force to remedy these defects."

"The other school believes that the world, imperfect as it is from the rational point of view, is the result of forces inherent in human nature. To improve the world one must work with those forces, not against them. This being inherently a world of opposing interests and of conflict among them, moral principles can never be fully realized but must at best be approximated through the ever temporary balancing of interests and the ever-precarious settlement of conflicts. This school, then, sees in a system of checks and balances a universal principle for all pluralist societies. It appeals to historical precedent rather than to abstract principles and aims at the realization of the lesser evil rather than of the absolute good." "This theoretical concern with human nature it actually is, and with the historical processes as they actually take place, has earned for the theory presented here the name of 'realism.'"

Morgenthau does not attempt to present a "systematic exposition of the philosophy of political realism," but presents six fundamental principles of Political Realism instead. I discuss two principles that I consider relevant in the context of this study: (1) "Political Realism believes that politics, like society in general, is governed by objective laws that have their roots in human nature." In other words: society is a rule-based system. Morgenthau does not make clear what these 'objective laws' are, and (2) "The main signpost that helps political realism to find its way through the landscape of international politics is the concept of interest defined in terms of power." "We assume that statesmen think and act in terms of interest defined as power, and the evidence of history bears that assumption out."

Morgenthau argues, “The concept of interest defined as power imposes intellectual discipline upon the observer, infuses rational order into the subject matter of politics, and thus makes the theoretical understanding of politics possible.” “A realist theory of international politics then, will guard against two popular fallacies: the concern with motives and the concern with ideological preferences.”

This so-called ‘Realist’ perspective results in rather simplistic and sometimes reprehensible conclusions. For example, Morgenthau argues, “Chamberlain’s politics of appeasement were, as far as we can judge, inspired by good motives; he was probably less motivated by considerations of personal power than were many other British prime ministers, and he sought to preserve peace and to assure the happiness of all concerned. Yet his policies helped to make the Second World War inevitable and to bring untold miseries to millions of people.”

As I show with this study, this analysis is fundamentally wrong: The Second World War (the fourth systemic war, 1939-1945) did not become inevitable because of Chamberlain and his likes. The Second World War, like other systemic wars, was produced by the internal dynamics of the System, and was necessary to rebalance the System, to allow for a new phase of growth, and in the case of the Second World War, a dual phase transition that was already in the making for centuries, since the inception of the finite-time singularity dynamic in 1495.

The Second World War (the fourth systemic war) was a deterministic event and would have emerged anyway in whatever appearance at that particular moment in time. Through the war logic that was leveraged by Realist reasoning, the singularity dynamic – interacting self-fulfilling prophecies that powered I the singularity dynamic with sufficient free energy – would have assured that a situation would have been presented to decision makers on time that would have justified these decision makers to engage in war.

According to Morgenthau, “International Politics, like all politics, is a struggle for power. “Whatever the ultimate aims of international politics, power is always the immediate aim.” “When we speak of power, we mean man’s control over the minds and actions of other men. By political power we refer to the mutual relations of control among the holders of public authority and between the latter and the people at large. Political power is a psychological relation between those who exercise it and those over whom it is exercised. It gives the former control over certain actions of the latter through the effect that the former has on the latter’s mind. That effect derives from three sources: the expectation of benefits, the fear of disadvantages, and the respect or love for men or institutions. It may be exerted through orders, threats, the authority of a man or an office, or a combination of any of these.”

“Domestic and international politics are but two different manifestations of the same phenomenon: the struggle for power. Its manifestations differ in the two different spheres because different moral, political, and social conditions prevail in each. Western national societies show a much greater degree of social cohesion within themselves than among themselves. Cultural uniformity, technological unification, external pressure, and, above all, a hierarchic political organization combine to make the national society an integrated whole set apart from other national societies. In consequence the domestic political order, is for instance, more stable and less subject to violent change than is the international order."

"All politics, domestic and international, reveals three basic patterns; that is, all political phenomena can be reduced to one of three basic types. A political policy seeks either to keep power, to increase power, or to demonstrate power." "The policy of prestige has rarely been recognized in modern political literature for what it is: the third of the basic manifestations of the struggle for power on the international scene."

"The concept of 'equilibrium' as a synonym for 'balance' is commonly employed in many sciences, including physics, biology, economics, sociology, and political science. It signifies stability within a system composed of a number of autonomous forces. Whenever the equilibrium is disturbed either by an outside force or by a change in one or the other elements composing the system, the system shows a tendency to re-establish either the original or a new equilibrium."

According to Morgenthau, "two assumptions are at the foundations of all such equilibriums: first, that the elements to be balanced are necessary for society or are entitled to exist and, second, that without a state of equilibrium among them one element will gain ascendancy over the others, encroach upon their interests and rights, and may ultimately destroy them. Consequently, it is the purpose of all such equilibriums to maintain the stability of the system without destroying the multiplicity of the elements composing it. If the goal were stability alone, it could be achieved by allowing one element to destroy or overwhelm the others and take their place. Since the goal is stability plus the preservation of all elements of the system, the equilibrium must aim at preventing any element from gaining ascendancy over the others."

"Two elements are the basis of international society: one is the multiplicity and the other the antagonism of its elements, the individual nations. The aspirations for power of the individual nations can come into conflict with one another – and some, if not most of them, do at any particular moment in history – in two different ways. In other words, the struggle for power on the international scene can be carried on in two typical patterns:" through direct opposition, or through competition. In case of 'direct opposition', "the balancing of opposing forces will go on, the increase in the power of one nation calling forth an at least proportionate increase in the power of the other, until the nations concerned change the objectives of their imperialistic policies – if the do not give them up altogether – or until one nation gains or believes it has gained a decisive advantage over the other. Then either the weaker yields to the stronger or war decides the issue."

In the other pattern (competition), the mechanics of the balance of power are identical, but do not – because of pragmatic reasons – result in war. According to Morgenthau, "the balance fulfills an additional function: aside from creating a precarious stability and security in the relations between certain states (A and B in this example), consists in safeguarding the independence of third state(s) (C in this example), against encroachments by A and B, and probably other states. In fact, the independence of this third (weaker) state 'C' is mere a function of the power relations existing between other A and B. In other words the function of the balance of power is (also) to preserve the independence of weak nations, that serves a clear purpose for the preservation - balancing - of the system." Morgenthau wrote, "small nations have always owed their independence either to the balance of power, or to the preponderance of one protecting power, or to their lack of attractiveness for imperialistic aspirations. The ability of such small nations to maintain their neutrality (like The Netherlands during the First World War) has always been due to one or the other or all factors." "The same factors are responsible for the existence of so-called buffer states - weak states located close to powerful ones and serving their military security."

Especially interesting is the case of Belgium, and the reasoning Morgenthau provided for its existence. Morgenthau explains that, "The outstanding example of a buffer state owing its existence to the balance of power is Belgium from the beginning of its history as an independent state in 1831 to the Second World War." Belgium was explicitly established by the Congress of Vienna to improve the balance of power in Europe. In other words, this state was created to prevent new destabilizing tensions from emerging and is a correction of and addition to the international order (of which the Congress of Vienna is an integral part) produced by the third systemic war in 1792–1815. Morgenthau explains how a strong focus on preservation and expansion of power by states in an anarchistic system contributes to a certain balance of power, of which 'small nations' are an integral part to ensure its functioning. Morgenthau's and the Realist School's reasoning show how selfish considerations of states contributed to the emergence and conservation of small states.

I explain in this study that the structure of the System (i.e., the size distribution of states) over time became more fractal because fractal structures support the balanced fulfillment of basic requirements by uneven states in an anarchistic system and minimize the production of tensions. I argue that the addition of Belgium to the System (as a 'new' state) contributed to the degree of fractality of the System and, by doing so, improved the ability of the system to further optimize its balancing function. Morgenthau describes that "the balancing process can be carried on either by diminishing the weight of the heavier scale or by increasing the weight of the lighter one." Morgenthau discusses various 'instruments' to achieve this, such as by 'divide and rule' policies, 'armaments', and 'alliances.' Alliances are considered "a necessary function – and its most important manifestation – of the balance of power operating within a multiple-state system."

"Nations A and B, competing with each other, have three choices in order to maintain and improve their relative power positions. They can increase their own power, they can add to their own power the power of other nations, or they can withhold the power of other nations from the adversary. When they make the first choice, they embark on an armaments race. When they choose the second and third alternatives, they pursue a policy of alliances." "Whether a nation shall pursue a policy of alliances is, then, a matter not of principle but of expediency. A nation will shun alliances if it believes that it is strong enough to hold its own unaided or that the burden of the commitments resulting from the alliance is likely to outweigh the advantages to be expected."

3.4 Synchronization through self-organized mass-deception

The singularity dynamic that I identified and described in this study unfolded regularly ('accurately') according to a 'schedule' that was already contained in the initial conditions of the System at its inception around 1495. In this paragraph, I address the question that was put forward in the introduction of this chapter, namely how the deterministic nature of war dynamics of the System is synchronized with the deliberate nature of human decisions regarding war. How and by what mechanisms do states make the right war decisions at exactly the right time?

I argue that the logic that is contained in the 'School of Political Realism' provided the necessary mechanisms that resulted in the finite-time singularity dynamic and ensured its regular unfolding. The security dilemma is intrinsic to anarchistic systems and is central to the Realism's war logic. In an anarchistic system, states are responsible for their own security and survival. An anarchistic system lags a generally accepted framework that allows for peaceful settlement of issues that unavoidably arise in anarchistic systems. The security dilemma implies that one state's security (provisions) constitutes another state's insecurity. The indivisibility of security, its zero-sum nature in anarchistic systems and its relational dimension, produces a self-reinforcing mechanism, leading to increasing levels of tensions and destructive energy, as I already explained.

An anarchistic system can only be reorganized through war; alternatives are not available. Because of the continuous increase in population, connectivity and rivalry between states, reorganization of the System – through systemic wars – is just a matter of time. States continuously monitor other states, issues, and their intentions. Moreover, because of the anarchistic nature of the System, and the rising number of issues and levels of tension in the System, states as a matter of time find reasons and justification to take necessary measures to improve their security by forming alliances and/or (preventively) deploying destructive energy. It is a matter of time before potential adversaries – these measures were aimed at – take similar (counter) measures, following the same 'realistic' logic. These counter measures then justify the initial measures that were taken. This – measures / counter-measures – dynamic is self-reinforcing.

The security dilemma not only constitutes a self-reinforcing mechanism; it also produces 'interacting self-fulfilling prophecies' between states.' A self-fulfilling prophecy is a prediction that directly or indirectly causes itself to become true, by the very terms of the prophecy itself, due to positive feedback between belief and behavior.

The School of Political Realism derives its 'predictive power' - and as a consequence its justification - from a self-fulfilling prophecy that is intrinsic to the security dilemma. All states are involved in these dynamics; it is just a matter of time before all states in an anarchistic system get involved in these mutually reinforcing dynamics and see their worst expectations become true, not aware that these tensions were created by their own doing.

The security dilemma and interacting self-fulfilling prophecies are integral components of the School of Political Realism. The Realistic School provided (and still provides) a powerful rule set and dogmas to decision-makers in states that justified the deployment of increasing levels of destructive power that were (unknowingly) necessary for the unfolding of the finite-time singularity dynamic (1495-1945).

The war logic the School of Political Realism provided and still provides an integral and indispensable component of the first and (now) second singularity dynamic. Political Realism 'is' the singularity dynamic, and vice versa. The Realistic School is the codification of the self-fulfilling prophecy that produced the decisions necessary for the singularity dynamic to develop and sustain.

Over time, during the unfolding of the finite-time singularity dynamic (1495-1945), the System developed increasingly outspoken and extreme political and military doctrines, justifying ever-increasing levels of destruction.

For example, in his war theory '*On War*', Clausewitz (19) obviously presented convincing (enough) arguments to generations of military leaders and politicians to accept 'total destruction' as a sensible military and political doctrine; according to Clausewitz, war is the continuation of politics with other means. The security dilemma could provide scientists, as well as military and political leaders, with the necessary argumentation. The singularity dynamic needed exactly such an extreme logic to be able to maintain its momentum, requiring the deployment of increasing levels of destructive energy at increasing frequencies.

This is a co-evolutionary process: the deployment of increasing levels of destruction (demanded by the singularity dynamic) needed justification and dogmas. Political Realism provided the necessary justification and dogmas. Political Realism produced the singularity dynamic, while the singularity dynamic then further radicalized the School of Political Realism.

We are under the assumption that we have 'free will,' and that we more or less freely choose between different courses of action. Contrary to what we believe and what we want to believe, at least as far as war decisions are concerned, this is not the case this study shows: war decisions do not qualify as 'free will.' Instead, these decisions are forced upon us and leave us no other choice than to comply; the security dilemma and interacting self-fulfilling prophecies will make sure of that. The 'insidious' logic of the School of Political Realism ensured (and will ensure) that ever-increasing levels of destructive power were (and will be) deployed with conviction.

War decisions (the singularity dynamic) qualify as self-organized mass-deception that is accomplished through a collective self-fulfilling prophecy. In fact, the name 'School of Political Realism' could not be more appropriate; and as I already observed, Political Realism provides us with a collective mechanism to make the perceived realties of states and their decision-makers come true.

3.5 School of Political Realism or School of Collective Self-Deception?

The School of Political Realism as a coherent thought system – consisting of a set of assumptions, logics, and expectations – unknowingly, but very cunningly, exploits our inability to make sense of complex systems and nonlinear dynamics that characterize these systems. Being an integral part of such a complex system obviously makes it difficult to detect (and accept) how it works. Anarchistic systems produce collective self-fulfilling prophesies that determine and shape its dynamics. The security dilemma is central to these interacting self-fulfilling prophecy dynamics.

In an anarchistic system it is not difficult for a Realist to prove himself correct: he gets what he prophesizes. Anarchistic systems never disappoint. These mechanisms make anarchistic systems into war-traps. As the 'finale' (1939-1945) of the singularity dynamic shows, only a direct risk of collective self-destruction along with the urge to survive could force decision makers to implement fundamental change.

Political Realism is not a superior theory, as Morgenthau and Kissinger want us to believe. Morgenthau and Kissinger are instrumental in a process of collective self-deception, contributing to the necessary sense making by acting as the intellectual justifiers of infinite levels of destruction. Political Realism does not qualify as a science; it is a pseudo-science at best. Political Realism in fact is a crystal ball that actually works by successfully exploiting self-fulfilling prophecies and a school of thought that gives us the impression of control and accurate prediction. It is a serious concern that we were (are) so easily misled by groupthink at such a scale, and that it can make us construct and consistently act on collective self-fulfilling prophecies that then lock us into an inescapable war trap without experiencing any serious levels of cognitive dissonance.

In the next evaluation, I focus on decisions of states that led to the First World War (the third systemic war, 1914-1918), and is an example of the actual workings of the School of Political Realism.

4 Evaluating "The Sleepwalkers: How Europe Went to War in 1914" by Christopher Clark

4.1 Introduction

Because interactive decision-making is at the heart of the System, I now discuss a study by Christopher Clark: "*How Europe Went to War in 1914*" (18). This study shows how the Realistic school of thought works in practice. Clark's study shows that war decisions in the end boil down to a simple yes or no binary question. 'Saturation' as defined by Mattick et al. (41) can also be observed as an information overload that hinders assessments. Other mechanisms that can be observed are: the growing feeling by decision makers that they are losing control (related to the inability to adequately and timely process incoming signals), and that time is increasingly against them, providing positive argumentation for urging preventive/pre-emptive war activity.

"*How Europe Went to War in 1914*," including the options that were taken into consideration by decision makers regarding war decisions belongs to the contingent domain of the System. These events were a reaction to a trigger that activated an underlying percolated network of fully connected vulnerable issue clusters. Because of the criticality of the System and the fractal structures of the globally percolated cluster at that point, the System became critical and produced a systemic war (the third systemic war, the First World War, 1914-1918).

Clark describes the aim of his study as follows: "This book thus strives to understand the July Crisis 1914 as a modern event. Questions of *why* and *how* are logically inseparable, but lead us in different directions. The question of *how* invites us to look closely at the sequences of interactions that produced certain outcomes." "The focus on *how* aims to identify the decisions that brought war about and to understand the reasoning or emotions behind them." "By contrast, the question of *why* invites us to go in search of remote and categorical causes: imperialism, nationalism, armaments, alliances, high finance, ideas of national honor, the mechanics of mobilization. The why approach brings a certain analytical clarity, but it also has distorting effect, because it creates the illusion of a steady building causal pressure; the factors pile up on top of each other pushing down on the events; political actors become mere executors of forces long established and beyond their control."

Clark's study focuses on 'how questions' related to dynamics in the contingent domain of the System. Clark is not aware of the existence of a deterministic domain that determines and shapes contingent dynamics. The timing, duration and intensity of the First World War (the third systemic war, 1914-1918) were already 'set' (dictated by the second law of thermodynamics), and contingent dynamics – shaped by interacting self-fulfilling prophecies between states – would ensure a timely 'emergence' of the First World War.

Clark observes, "The key-decision makers – kings, foreign ministers, ambassadors, military commanders and a host of lesser officials – walked towards danger in watchful, calculated steps. The outbreak of war was the culmination of chains of decisions made by political actors with conscious objectives, who were capable of a degree of self-reflection, acknowledged a range of options and formed the best judgments they could on the basis of the best information they had to hand. Nationalism, armaments, alliances and finance were all part of the story, but they can be made to carry real explanatory weight only if they can be seen to have shaped the decisions that – in combination – made war break out."

Clark's also observes, "It is a central argument of this book that the events of July 1914 make sense only when we illuminate the journeys travelled by the key decision-makers. To do this, we need to do more than simply revisit the sequence of international 'crises' that preceded the outbreak of war - we need to understand how those events were experienced and woven into narratives that structured perceptions and motivated behavior." "When decision-makers discoursed on the international situation or on external threats, were they seeing something real, or projecting their own fears and desires on their opponents, or both? The aim has been to reconstruct as vividly as possible the highly dynamic 'decision positions' occupied by the key actors before and during the summer of 1914."

In the introduction to his study, Clark observes, "Some of the most interesting recent writing on the subject has argued that, far from being inevitable, this war was in fact 'improbable' - at least until it actually happened. From this it would follow that the conflict was not the consequence of long-run deteriorating, but of short-term shocks to the international system." This is a fundamental misrepresentation of the nature and dynamics of the System, as this study shows: This war – as were the other (three) systemic wars the finite-time singularity produced during the period (1495-1945) – was unavoidable and forced upon the System by a deterministic underlying dynamic of the network.

Referring to Clark's observation above, the First World War was inevitable because the deterministic rules that apply to the System and its dynamics (in particular the second law of thermodynamics) ensured that enough tensions were produced, that a vulnerable cluster percolated the System, and that a trigger put the tensions (free energy) in the System to work to implement an upgraded order that allowed for a lower energy state of the System.

In the next paragraphs, I take a closer look at some of Clark's observations and statements concerning "*How Europe Went to War in 1914*." I only comment on his observations if these comments aid in increasing understanding of my framework.

4.2 Observations and comments

Clark observes that, in the decennia preceding the First World War, (what I call) 'alliance dynamics' transformed the System from a multipolar System, in which a plurality of forces and interests balance each other in precarious equilibrium, to a bipolar System: "You see a bipolar Europe organized around two alliance systems … the profiles of two armed camps are clearly visible. The polarization of Europe's geopolitical system was a crucial pre-condition for the war that broke out in 1914," according to Clark.

Clark further observes, "The bifurcation into two alliance blocs did not cause the war; indeed it did as much to mute as to escalate conflict in the pre-war years. Yet without the two blocks, the war could not have broken out in the way that it did. The bipolar system structured the environment in which the crucial decisions were made."

I consider alliance dynamics and the system configurations that they result in as an integral part of the dynamics in the contingent domain of the System. During its life span (1495-1945), the anarchistic System crystalized into different configurations (I now refer to political alliances, not to the fractal state structures). However, when cycles are used as the unit of analysis for the System's dynamics, it is not possible to discern certain typical patterns in configurations during successive relatively stable periods. There seems to be no correlation between the type of these configurations and the System's war dynamics of the System.

Historians, such as Kaplan (35), extensively studied these configurations. My study shows that there is no relationship between these configurations and war dynamics of the System. It is also useful to observe, as this example shows, that bipolarity does not automatically imply that the number of the degrees of freedom of the system are then reduced to two. If this were true, bipolarity and non-chaotic war dynamics would always go hand in hand; however, this study shows, this is not the case.

It is the level of intensity of rivalries between states, not bipolarity as such, that determines the degrees of freedom of the System.

Clark further observes that also in case of a bipolar System, states cannot afford to ignore the interactions and positions of other states: "For Russia, as for Britain this was still a world in which there was more than one potential enemy. Beneath the scaffolding of the alliances lurked older imperial rivalries." The effect of this is, that despite the bipolarity of the System, a third degree of freedom still impacted on the war decisions of states.

Clark also observes differences in decision-making processes and procedures in governments: "a very cursory look at the governments of early twentieth-century Europe reveals that the executive structures from which policies emerged were far from unified. Policy-making was not the prerogative of single sovereign individuals. Initiatives with a bearing on the course of a country's policy could and did emanate from quite peripheral locations in the political structure. Factional alignments, functional frictions within government, economic or financial constraints and the volatile chemistry of public opinion all exerted a constantly varying pressure on decision-making processes. As the power to shape decisions shifted from one node in the executive structure to another, there were corresponding oscillations in the tone and orientation of policy. This chaos of competing voices is crucial to understanding the periodic agitation of the European system during the last pre-war years."

This study shows that these sometimes significant differences in decision-making processes and dynamics of states, in fact do not impact on the fundamental binary nature of war decisions: Ultimately, all of these different processes converge on just a single question: proceed with war or not? At their core, all of these decision-making processes qualify as binary decision-making processes with externalities and thresholds. This study also shows that the organization, the players in these processes, and the arguments they make, do not matter in the grander scheme. The System will produce a war; the war logic contained in considerations by decisions-makers will see to that through interacting self-fulfilling prophecies.

Clarke describes the psychological process in which war becomes unavoidable as follows: "… a kind of temporal claustrophobia that we find at work in the reasoning of many European statesmen of this era - a sense that time was running out, that in an environment where assets were waning and threats were growing, any delay was sure to bring severe penalties." I describe this process – from a somewhat different perspective – as follows: Decision makers (regarding war decisions) only act as figurants, and must obey a deterministic 'playbook'; this playbook is provided by the highly deterministic self-organized singularity dynamic which itself is produced through a multitude of interactions between states, that aim to ensure the fulfillment of their basic requirements survival. The 'logic' the deterministic dynamics impose on decision-makers constitute a war-trap, decision makers are increasingly confronted with this war trap when the System is about to become critical, and all issues in the System become connected.

Clark made the following observation, shared by other historians, regarding the last two pre-war years, "… one of the most curious features of the last two pre-war years, namely that even as the stockpiling of arms continued to gain momentum and the attitudes of some military and civilian leaders grew more militant, the European international system as a whole displayed a surprising capacity for crisis management and détente."

These features are, as this study shows, not as curious as Clark suggests. This is normal behavior for the category systems the System also belongs to, when these systems are about to reach the upper boundary of the cascade (war) window. Watts (72) describes this behavior as follows: "Here (*IP: shortly before the System becomes critical and produces a systemic war*), the propagation of cascades is limited not by the connectivity of the network, but by the stability of the vertices" (*IP: vertices are nodes of a network; states in the context of this study*). "A percolating vulnerable cluster, however, still exists, so very rarely a cascade will be triggered in which case the high connectivity of the network ensures that it will be extremely large…" At that stage, Watts explains, "… the system will in general be indistinguishable from one that is highly stable, exhibiting only tiny cascades for many initial shocks (*IP: like the first Balkan Wars, that did not – could not from a network perspective –*

escalate) before generating a massive, global cascade in response to a shock that is a priori indistinguishable from any other."

Clark further describes how events tended to become connected, indicative for the percolation of the underlying vulnerable issue clusters in the System: "By the spring of 1914, the Franco-Russian Alliance had constructed a geopolitical trigger along the Austro-Serbian frontier. They had tied the defense policy of three of the world's greatest powers to the uncertain fortunes of Europe's most violent and unstable region." "But since they viewed their own actions as entirely defensive and ascribed aggressive intentions solely to the enemy, the key policy-makers never took seriously the possibility that the measures they were themselves enacting might be narrowing the options available to Berlin. It was a striking example of what international relations theorists call the 'security dilemma', in which the steps taken by one state to enhance its security 'render the others more insecure and compel them to prepare for the worst.'"

This dynamic demonstrates how the security dilemma works in practice, and how issues and states become increasingly connected in the System. This is percolation 'in progress', on short notice producing a 'percolation condition', implying criticality and systemic war.

Finally, I discuss Clark's observation that long-term historical transitions did not produce the First World War, which he explains as follows. "Crucial to the complexity of the events of 1914 were rapid changes in the international system (...). These were not long-term historical transitions, but short-range realignments (...) it draws our attention to the place of short-range, contingent realignments in shaping the conditions under which the crisis of 1914 unfolded."

Not surprisingly, I do not support this view. These observations concern only dynamics in the contingent domain of the System. These contingent dynamics did not cause this and other systemic wars the System experienced.

The 'realignments' and other events Clark refers to qualify as 'crystallizations' of tensions in the contingent domain of the System in response to the deterministic buildup of free energy (tensions) in the System.

4.3 Evaluation

It is evident that Clark, as well as Tilly, Spruyt, and other historians, are not aware of the existence of a deterministic underlying domain that, to a very high degree, determined and shaped the war dynamics and direction of development of the System. Historical analysis cannot be complete and accurate if this deterministic domain is not identified or ignored: deterministic and contingent dynamics interact, coevolve. For a thorough understanding of historical and social processes, it is also necessary that the interface between the deterministic and contingent domain is understood and analyzed.

PART VI

THEORIES, TERMS & DEFINITIONS

The problem is not merely

man against man or nation against nation.

It is man against war.

Dwight Eisenhower, April 4, 1956

Abnormal (non-chaotic) non-systemic war dynamics
During two specific periods of time – respectively from 1657until 1763 (the first exceptional period), and from 1953-1989 (the second exceptional period) – the System produced 'abnormal' war dynamics. The fact that the non-systemic war dynamics during these two periods were non-chaotic in nature, makes them abnormal.

In both cases, these abnormal war dynamics can be attributed to a temporary reduction in the numbers of degree of freedom of the System to two. During the first exceptional period this was a consequence of the intense rivalry between Britain and France; during the second exceptional period because of the intense rivalry between the United States and the Soviet Union, and the respective hierarchies they controlled.

In case of (at least) three degrees of freedom the System produces chaotic non-systemic war dynamics; in case of two degrees of freedom, periodic or subdued

war dynamics, as was respectively the case during the first and second exceptional period.

Whereas chaotic war dynamics are intrinsically unpredictable, and more constrained, periodic war dynamics are more regular, but also more 'extreme' (unrestrained).
See also: *exceptional period(s)*.

Accelerating cycle
The finite-time singularity dynamic the anarchistic System produced during the period (1495-1945) was accompanied by four accelerating cycles; each cycle consisting of a relatively stable period followed by a systemic war. Because of the increasing connectivity of the System, the pace of life of the System increased; as a consequence, successive cycles accelerated with a constant rate.

Accelerating network
The function of regulatory networks is to regulate the dynamics (and certain properties) of networks, to ensure its functioning and performance.

The System also requires regulation to ensure a certain 'balance' that enables the fulfillment of basic requirements of uneven states in in the anarchistic System. International orders are implemented to achieve this, and determine the regulatory capabilities of the System.

International orders are not 'top down' arrangements; states in the System are sovereign. The System qualifies as a parallel-processing network, which consists of a network of nodes (states, in this context) that simultaneously process information and calculate the appropriate responses to threats and opportunities. In the System, each state makes its own selfish calculations, but uses, at least to a certain extent, the same 'order' as other states.

Whereas at system level the System could be considered a parallel-processing network, states – but also the dedicated hierarchies that were implemented through the fourth systemic war (The Second World War, 1939-1945) that constituted a phase transition – also need to possess a certain 'independent' regulatory capacity in order to survive.

The connectivity of regulatory networks has to grow at accelerating rates to ensure their function. Accelerated growth rates are because of the accelerating growth requirements unsustainable.

I assume that regulation of the System (through international orders) at a certain point becomes problematic because the required (accelerated) growth of its regulatory network cannot be sustained anymore. When the System becomes critical, 'all' issues in the System become connected (the correlation length of the System at the critical point is one), this leads to saturation and collapse of the regulatory network (the international order) and the anarchistic System cannot any longer balance contradictory requirements.

In the article *Accelerating networks* (41). discuss accelerating networks, their typical dynamics, and how the unavoidable limitations that regulatory networks encounter can be solved to ensure their continued effectiveness. The authors present two categories of solutions for this (unavoidable) problem: (1) reduction in connectivity requirements of regulatory networks and (2) changes in the physical basis of the system (that requires regulation), as I will discuss later.

The authors observe that, in order to perform their functions in providing awareness and enabling effective global responses, regulatory networks must be able to rapidly integrate information about the current and expected state of the network, including information from the nodes that make up the network.

Mattick et al. formulated the requirements of regulatory networks as follows: "In any highly competitive system – whether biological or industrial – the speed and efficiency of organization, and the sophistication of response to changing circumstances are critical determinants of the system's survival and success." However, Mattick et al. also observe "Systems that require integral organization to function in a competitive environment are dependent on, and ultimately constrained by, their accelerating regulatory architecture: Connectivity and the proportion of the system devoted to regulation must scale faster than function in organized complex systems." "Such networks are termed 'accelerating' networks." "This in turn means that the size and complexity of such systems (*IP: regulatory networks*) must sooner or later reach a limit where the number of possible connections becomes saturated or where the accelerating proportional cost of these connections becomes prohibitive." "Maximum integrated connectivity occurs when all nodes are connected to all others (a proportional connectivity of one), which means that the total number of connections in such networks scales quadratically with network size. Even if the proportional connectivity is much less than one, the number of connections must still scale quadratically, otherwise global connectivity will decline."

"These accelerating connecting requirements (in order to be able to operate in a globally responsive way), in principle and in practice, impose an upper limit on the functional complexity that integrated systems can attain." "Because of the need for accelerated growth, these networks become saturated at a certain point, and then collapse: Accelerated growth is unsustainable." Mattick et al. proposed two solutions to this problem: a reduction in connectivity or a change in the physical basis of the system.

Mattick et al. discuss two solutions to the unsustainability of accelerated growth requirements of regulatory networks: a reduction in connectivity or "changing the physical basis of the connections and reducing their proportional cost."

Mattick et al. observe: that a reduction in connectivity comes at a price: "Reduction in connectivity reduces the functional integration of the network, leads to fragmentation, as is observed, for example, in the transition of social networks from small communities to cities."

Mattick et al. further explain, "If integration of node activity is absolutely required for the operation of the system or for its competitive survival, the functional complexity of the system can only be increased beyond the existing limit by increasing the number of connections." "This can be achieved by changing the physical basis (*IP: Mattick et al. in particular focus on computer platforms and integrated circuits*) of the connections and reducing their proportionate cost (...)." In other words, according to Mattick et al., "When connection limits cannot be raised, or functional components cannot directly communicate with each other, the alternative is to introduce dedicated hierarchies."

Mattick et al. explain that this requirement results in a dynamic in which quasi-stationary phases are periodically punctuated by periods in which innovations are and must be introduced to avoid a collapse of the system; "... accelerating networks show quasi-stationary phases at growth in their complexity and capability, asymptotically approaching maxima until the ceiling is lifted." 'Lifting the ceiling' implies, in the context of this study, a phase transition.

A punctuated equilibrium dynamic can also be observed in the dynamics of the System. The finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period constitutes a punctuated equilibrium dynamic. Ultimately (1939-1945) the singularity dynamic produced a phase transition that led to the implementation of two dedicated hierarchies (in respectively Western and Eastern Europe) that eventually merged into one hierarchy when in 1989-1991 the Soviet Union collapsed. Through these two dedicated hierarchies anarchy was neutralized within these 'structures', dramatically reducing the need for the level of functional integration the regulatory networks of respective hierarchies had to accomplish. Within the respective hierarchies, the security dilemmas were neutralized.

The fourth systemic war (the Second World War, 1939-1945) constituted this phase transition and, using terminology by Mattick et al., 'lifted the ceiling' of the System (in Europe, the core of the System).

Three systemic wars preceded the phase transition. Through these three systemic wars, the System implemented upgraded orders that contributed, at least temporarily, to the regulatory capacity of the System. Using terminology by Mattick et al., these upgraded orders (organizational innovations) altered the 'basis of the control architecture' of the anarchistic System.

By introducing dedicated hierarchies, the System solved a number of problems, including the saturation of its regulatory network. However, as Mattick et al. also explain, additional hierarchies have a price and produce new challenges. Mattick et al. make the following observations concerning additional hierarchies in other types of systems: "These regulatory (*IP: dedicated hierarchies*) systems still scale nonlinearly (albeit not quadratically) with system size in a manner that is dependent on the number of nodes being managed at each step." "Moreover, these hierarchies have their own costs. Each level of regulatory hierarchy introduces new delays, increases noise and stochastic errors, and results in loss of detailed information from within sub-networks across the system." It is obvious that the 'European integration' and supporting structures that are implemented' also encounter these costs.

"These shortcomings increase with greater levels of regulation and with network size (that is the bigger the organization, the greater the number of management levels), limiting system coherence and ultimately imposing upper limits on the size and functional complexity that such systems can attain. Evidently, the most effective network organization is the one that is most completely interconnected." "Moreover, any network that requires time critical integration to operate and to be competitive suffers decreasing benefits as size increases. The decrease in benefits can be in terms of connection costs or organizational costs (information loss, increases in noise and processing time), which ultimately constrain the size and complexity of the network."

Even if an additional hierarchy is fully implemented, it can still be overwhelmed by the demands that are made on it. Its increased internal diversity (this is presently also an issue in Europe) sets higher standards for its control. Internal and external pressures can cause new hierarchies to fail and cause a system to fragment. The collapse of the Eastern hierarchy (i.e., the Soviet Union) can be attributed to its inability to ensure a balanced fulfillment of the basic requirements of states that were subordinate to this hierarchy due – in large part – to a single-minded focus on security and control. Presently the European Union confronts similar problems.

I argue that the finite-time singularity accompanied by four accelerating cycles that unfolded during the period 1495–1945 was instrumental in implementing the dedicated non-anarchistic hierarchies in Europe. In fact, the singularity dynamic can be seen as a step in the long-term process of social integration and expansion in the System that already started thousands of years ago when families and tribes began to cooperate to create better conditions to fulfill their basic requirements and survive. This long-term SIE process is still unfolding.

Alliance dynamics
States form alliances to manage risks, and ensure fulfillment of their basic requirements. The number of alliances that are formed or dissolved by Great powers in the System during a year determines the alliance dynamics of the System at that point in time. The alliance dynamics of the System (1820-present) show that alliance dynamics typically intensify shortly before systemic wars (and in a number of other cases not related to the start of wars). Because of their short 'lead-time' (intensification before a systemic war) alliance dynamics cannot practical early warning signals.

Anarchistic end state
During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the robustness, fragility and structural stability of successive cycles developed very regularly to absolute levels. In 1939, the moment the properties reached 'absolute' levels, the System reached the 'anarchistic end state', and free energy (tensions) the anarchistic System produced could no longer be put to use to further improve the order of the anarchistic System, and ensure compliance with the second law of thermodynamics. The anarchistic end state and the critical connectivity threshold of the anarchistic System are related phenomena.

Anarchistic system
The System lacks a 'legitimate' integrative structure that is accepted by states in the System. States in an anarchistic system are considered sovereign and can govern themselves without 'outside' interference. States in an anarchistic System are responsible for their own security (the fulfillment of their basic requirements). The security dilemma is intrinsic to the dynamics of anarchistic systems: "a state's security is another state's insecurity". As Spruyt puts it: "Given the anarchical nature of the international system, force is viewed as the final arbiter regarding the viability of any institution" (66).

Attractor
"The general definition of an attractor is a set of points or states in state space to which trajectories within some volume of state space converge asymptotically over time. Thus, in addition to simple steady states, continuous dynamical systems may admit of more complex attractors. The simplest of these is a limit cycle, or hoop of states. If released on the hoop, the system flows around the hoop repeatedly. Over time, the variables exhibit a repetitive oscillation. The hoop is called a limit cycle because points not on it lie on trajectories which spiral either in or out and ultimately converge on it in the limit of infinite time. Thus a stable limit cycle drains some basin of attraction. Just as a steady state is a zero-dimensional attractor in an N-dimensional state space, a limit cycle is a closed one-dimensional attractor in higher-dimensional state space.

In addition to these classes of attractors, strange, or "chaotic" attractors exist.

The interesting property of such attractors is that, if the system is released from two points on the attractor that are arbitrarily close to each other, the subsequent trajectories remain on the attractor surface but diverge away from each other. After a sufficient time flowing on the attractor, the two trajectories can be arbitrarily far apart on it. The first critical novel feature found in strange attractors but not in steady states, limit cycles, and so forth is due to this divergence of trajectories on the attractor. It is a sensitivity to initial conditions. Tiny differences in initial conditions make vast differences in the subsequent behavior of the system. In contrast, a system with a stable limit cycle squeezes all flows onto the same hoop of states; hence nearby initial points are still nearby later on.

The second feature to notice about strange attractors is that they may be of very low dimensionality even in a high-dimensional state space. Thus a system may have 100 variables, but flow may be restricted to a strange attractor of two dimensions, a folded surface closing back on itself in that 100-dimensional space. From the point of view of the entire state space, the attractor is a very small object indeed. The system is boxed into a tiny volume of state space even though its behavior within that small volume is chaotic in the precise sense of high sensitivity to initial conditions. This point is very important to stress, for the behavior of such a system which exhibits low-dimensional chaos is much more orderly than the behavior of a system which wanders through vast tracts of state space on high-dimensional attractors." This definition is based on Kauffman (36).

Attrition warfare

See also: *hybrid/community warfare* and *maneuver warfare*.

Auto-correlation

Autocorrelation is the cross-correlation of a signal with itself. Informally, it is the similarity between observations as a function of the time lag between them. It is a mathematical tool for finding repeating patterns, such as the presence of a periodic signal obscured by noise, or identifying the missing fundamental frequency in a signal implied by its harmonic frequencies. It is often used in signal processing for analyzing functions or series of values, such as time domain signals (see also: wikipedia.org)

Basic Requirements

I assume that individual humans and social systems, including states, must fulfill four interdependent categories of basic requirements in order to 'function' and to survive; see table below (16), (46), (47).

Basic requirements of social systems	
Basic requirements	Subsystem
(1) Energy, necessities of life, and (2) wealth.	Economic system
(1) Internal and external security and (2) the potential to influence the behaviour of individuals and other (sub)systems, internally as well as externally.	Threat system
(1) Individual and collective identity and (2) the development of individual and collective identities.	Value system (religion, culture)
(1) Internal and external consistency and balancing, (2) direction for the development of the system, (3) legitimacy/acceptance of the (political) leadership of the system, and (4) the potential to control the environment of the social system.	Integrative system

Table 124 *This table provides an overview of four categories of basic requirements that social systems must fulfill to survive.*

I assume that individual and collective needs of respectively individuals and social systems (including societies) are closely related. The purpose of cooperation and organization is often motivated by opportunities they provide to better leverage economies of scale and scope to (better) fulfill basic requirements.

In my explanation of the concept of 'basic requirements' I will focus on 'social systems' (not on individual humans and their needs), and in particular on 'states'. I consider states organizational structures that also must fulfill certain needs; not only of its 'components' - individuals, and subsystems - but also to ensure its own survival as an organizational structure with certain needs, in an anarchistic environment. States like individuals, are an integral part of – and interact with – their environment. The environment is more or less structured and organized. The System – including its 'organization, that is its international order – constitutes the 'environment' of states, of which they (also) are an integral part. As I will explain later, states and the System interact; they co-evolve.

States – as collectives of individuals and subsystems – must fulfill certain basic requirements. For example, sufficient resources must be (made) available to ensure the provision of food, and the production of goods and services. States also require a certain level of security. In an anarchistic system, states are themselves responsible for their security.

Individuals as well as groups and social systems, typically develop and need identities. Identities provide 'meaning', direction, and social cohesion. States often have a certain 'identity' that developed over time, and are (in some respects) an organizational manifestation of a certain pre-existing identity. Besides an economic, threat and value system, social systems need an integrative system that ensures the balanced integration of all these requirements, and the subsystems these requirements bring about.

The fulfillment of the four categories of basic requirements needs to be balanced, to achieve optimization. The four requirements are closely related; they overlap and require a certain level of consistency and internal and external balancing. Consistency and balancing of each basic requirement is necessary not only in relation to the other (three) basic requirements of the same system, but also in relation to other basic requirements of other social systems. Because over time states (and societies they support) became more interdependent, the importance of (the need for) external balancing increased.

Balancing requires direction and 'control': the development and implementation of strategies and policies, for example. The 'competition' between basic requirements, requires constant balancing and prioritizing. The value system, for example, has the tendency to compete with the integrative (political) system. These two subsystems do not always 'match', and require (periodic) adjustment of one or both, to ensure a (potentially) destructive dynamic.

Each basic requirement delivers a certain set of 'services' to the social system it supports and of which it is an integral part.

The System provides a 'context' to states; a context in which states must operate and fulfill their basic requirements. To that end states try to influence the System's structure and organization. Over time, this context – the System – has become more important for states: states have become increasingly connected and interdependent.

During the 1495-1945 period, the state emerged as the 'optimal' organizational structure, best able to fulfill basic requirements of growing populations of states in an anarchistic system.

The System should also provide certain 'services' to its 'members' to help them meet their basic requirements. The ability of the System to deliver these services – its functionality – depends on various factors, including its connectivity. If the System – its 'order' – becomes (increasingly) ineffective, its legitimacy will be negatively affected.

Basic requirements are not static, but continuously evolve and change.

In an anarchistic system 'power' (the potential to influence), status and prestige play an important role in the ability of states to fulfill their basic requirements.

Integration as well as expansion contribute to the ability of states to fulfill their basic requirements.

BCD, Battle Casualty Deaths

BCD is the measure for severities of wars; BCD stands for Battle Casualty Deaths: The number of battle-connected deaths of military personnel of Great Powers that are involved in the war.

Bifurcation

Instead of the term 'phase transition', sometimes the term 'bifurcation' is used. Bifurcations are analog to phase transitions, but studied from a dynamical systems perspective. A bifurcation is a qualitative change in the dynamics of a system that takes place under continuous variation of a parameter.

Kauffman (36) describes a bifurcation as follows: A point in parameter space reflects a specific combination of all parameter values. "Any point in parameter space corresponds to a fixed set of parameters and thus to a fixed set of basins of attraction and attractors in the corresponding state space of the dynamical system. The set of basins of attraction is often called the basin portrait of the dynamical system."

"The next question to address is this: What happens if the parameters are changed gradually? The key idea is that, as parameters change slowly, the trajectories and attractors typically change slowly also. That is, the basin portrait of the system alters smoothly. For particular changes of the parameters, however, sudden dramatic changes in trajectories and attractors can occur. Such sudden changes are called bifurcations in the behavior of the dynamical system."

I reserved the term 'bifurcation' for the qualitative changes in the dynamics of the System caused by changes in the number of degrees of freedom (n) of the System. The System experienced four bifurcations: *in 1657* preluding the first exceptional period, when the war dynamics changed from chaotic ($n > 2$) to periodic ($n = 2$); *in 1763* when the System resumed chaotic war dynamics, *in 1953* at the start of the second exceptional period (the Cold War) when war dynamics became 'subdued', and *in 1989* when the System resumed chaotic dynamics. The level of rivalry in the System between Great Powers determines the number of degrees of freedom of the System, in other words, the nature of its non-systemic war dynamics.

Binary decisions (with externalities and thresholds)

War decisions can be considered binary decisions: states decide to 'go to war' or 'not go to war' their state (condition) is (and that respect) either 'active' ('on'), or 'inactive' ('off'). I assume that war decisions by states to a high degree depend on the condition ('war' or 'no war') of other states they are connected to. The number of other states that must switch to 'war' for a particular state to make a similar decision determines its threshold. War decisions of states qualify as binary decisions ('war' or 'no war') with externalities (other states to a high degree determine a state's condition) and thresholds (thresholds apply to 'switches' in state).
See also: *Cascade dynamics, cascades triggered by shocks*, and *Decision-making.*

Binary network, dynamics of binary networks

A binary network consists of nodes that have two possible states of activity: on/off or active/inactive for example. I consider the System a network of binary nodes (states); each state can decide to 'go to war' or decide 'not to go to war'; or be respectively 'at war' or 'not at war'.

See also *Boolean networks.*

Boolean network

Instead of binary networks Kauffman uses the term 'Boolean networks' (36). "Boolean networks are systems of binary variables, each with two possible states of activity (on and off), coupled to one another such that the activity of each element is governed by the prior activity of some elements according to a Boolean switching function".

"... NK Boolean networks permit us to study the emergence of order in systems coordinating the activities of thousands or even billions of elements." In so-called "NK Boolean networks, each element has two possible states of activity: active or inactive; a network links the activity of each of its N elements to the prior activities of K other elements. Random Boolean networks are a vast family of disordered systems." The 'binary networks with externalities' Watts introduced in his study also qualify as random Boolean networks (72).

"Boolean networks are made up of binary, on-off variables." States making up the System can be considered the Boolean variables of this system. The '*on*' state represents a condition of 'war', and the '*off*' condition a condition of 'no war.' "A network has N such variables. Each variable is regulated by some of the variables in the network, which serve as its inputs. The dynamical behavior of each variable, whether it will be active or inactive at the next moment, is governed by a logical switching rule, or Boolean function. The Boolean function specifies, for each possible combination of current activities of the input variables, the activity of the regulated variable at the next moment." In the System, the Boolean functions of states are defined by their basic requirements, perceived threats, and 'implemented' in thresholds that impact on decisions, etc.

"For example, an element with two inputs might be active at the next moment if either one or the other or both inputs are active at the current moment; this is the Boolean 'or' function. Alternatively, the element might be active at the next moment only if both inputs are active at the present moment; this is the Boolean 'and' function. Let K stand for the number of input variables regulating a given binary element. Since each element can be active or inactive, the number of combinations of states of the K inputs is two." "For each of these combinations, a specific Boolean function must specify whether the regulated element is active or inactive. Since there are two choices for each combination of states of the K inputs, the total number of Boolean functions F of K inputs is F = 2 to the power K."

"The number of possible Boolean functions increases rapidly as K increases. As we shall see, special subclasses of the possible Boolean functions are important for the emergence of orderly collective dynamics in large Boolean networks. If a network has no inputs from outside the system, it is considered to be autonomous and its behavior depends on itself alone. Such a network is specified by choosing, for each binary element, which K elements will serve as its regulatory inputs and assigning to each binary element one of the possible Boolean functions of K inputs."

"The simplest class of Boolean networks is synchronous, which means that all elements update their activities at the same moment. To do so, each element examines the activities of its K inputs, consults its Boolean function, and assumes the prescribed next state of activity." The System does obviously not qualify as a synchronous Boolean network: states take the behavior of other states (and their Boolean functions) in consideration, and they also anticipate on (expected) activities of other states, but do not (necessarily) update their activities at the same time. Furthermore 'Boolean functions' of states evolve and are as a consequence dynamic.

"Thus, at each moment, the system passes from a state to a unique successor state. Over a succession of moments, the system passes through a succession of states called a trajectory."

"The first critical feature of autonomous Boolean networks is this: Since there is a finite number of states, the system must eventually reenter a state previously encountered; thereafter, since the system is deterministic and must always pass from a state to the same successor state, the system will cycle repeatedly around this recurrent state cycle. These state cycles are the dynamical attractors of the Boolean network. The set of states flowing into one state cycle or lying on it constitutes the basin of attraction of that state cycle."

"A structural perturbation is a permanent 'mutation' in the connections, or Boolean rules, in the Boolean network." A Systemic War, when a new international order is designed and implemented, is such a 'permanent' 'mutation' in the Boolean rules of the 'Boolean' System. As development of the System in the long-term shows, this permanence is relative. In the longer term, the System does not qualify as structurally stable.

Kauffman further argues that random Boolean networks can exhibit three regimes of behavior, see: *Regimes of behavior of Boolean networks.*

Bottom-up mechanism

See: *Top-down mechanism.*

Brittleness of the anarchistic System

The condition of the anarchistic System shortly before its collapse in 1939, can be described as 'brittle'; at that point, the anarchistic System's brittleness had become 'absolute', and additional stress (tensions), could not be put to work ('absorbed') by further 'deforming' its structures, and instead caused these structures to fracture.

The increasing permanence of the Great Power status hierarchy in Europe, and the increasing fractality of states structures, are indicative for the increasing structural stability of the structure(s) of the anarchistic System.

Quantitative analysis of these three properties shows that during the fourth relatively stable period (the fourth international order, 1918-1939) the anarchistic System became 'absolute' robust (and could no longer produce non-systemic energy releases (non-systemic wars) as a consequence), 'absolute' fragile, and 'absolute' stable.

At the same time (1939), when the (structures of the) anarchistic System could not further evolve – and put free energy to work for a 'meaningful' purpose – the anarchistic System produced infinite amounts of free energy (tensions); as a consequence, the anarchistic System collapsed.

Cascade dynamics, cascades triggered by shocks

According to Watts (72), "The origin of large but rare cascades that are triggered by small initial shocks is a phenomenon that manifests itself as diversely as cultural fads, collective action, the diffusion of norms and innovations, and cascading failures in infrastructure and organizational networks." I argue that systemic wars also qualify as large but rare cascades that are triggered by relatively small shocks.

In the research paper titled "*A simple model of global cascades on random networks*" (72), Watts presents a possible explanation of this phenomenon in terms of a sparse, random network of interacting agents whose decisions are determined by the actions of their neighbors according to a simple threshold rule. The main objective of Watts' paper is "to explore how the vulnerability of interconnected systems to global cascades depends on the network of interpersonal influences that governs the information that individuals have about the world, and therefore (governs) their decisions." This objective, as well as the model he studied to explore the relationship between the structure and dynamics of certain networks, has important similarities with the object of my study. Watts' research helps us to better understand how the susceptibility of the System to war depends on the properties of the network of issues and accompanying tensions that percolates the System, as well as how decisions are made in this network. Subsequently, I discuss the following subjects: (1) several definitions and concepts related to dynamics of binary networks, (2) so-called vulnerable (issue) clusters and their cascades, (3) two types of connectivity regimes that determine and shape the dynamics of the System, (4) typical characteristics of non-systemic war dynamics that precede systemic wars, (5) 'robust yet fragile' properties of the System, and (6) the development of 'organizational stability' of the System

Watts focuses on how "small initial shocks can cascade to affect or disrupt large systems that have proven stable with respect to similar disturbances in the past." Watts' approach concentrated on two quantities in particular, namely (1) "the probability that a global cascade will be triggered by a single node (or small seed of nodes)," where a global cascade is defined as a "cascade that occupies a finite fraction of an infinite network;" and (2) "the expected size of a global cascade once it is triggered." A global cascade is not necessarily a system-sized cascade according to Watts. "These phenomena are all examples of what economists call information cascades (which are here called simply cascades), during which individuals in a population exhibit herd-like behavior because they are making decisions based on the actions of other individuals rather than relying on their own information about the problem." In the case of decision making in the System (I refer to war decisions in this context), herd-like behavior also exists, as I will explain later.

"Although they are generated by quite different mechanisms, cascades in social and economic systems are similar to cascading failures in physical infra-structure networks and complex organizations in that initial failures increase the likelihood of subsequent failures, leading to eventual outcomes that, are extremely difficult to predict, even when the properties of the individual components are well understood." "Not as newsworthy, but just as important as the cascades themselves, is that the very same systems routinely display great local stability in the presence of continual small failures and shocks that are at least as large as the shocks that ultimately generate a cascade." This phenomenon can also be observed in the System, for example in the period before the third systemic war (the First World War) was triggered. Previous shocks like the Balkan Wars, two conflicts that occurred in 1912 and 1913 in the Balkans, did not generate a significant shock (i.e., a global cascade, response), whereas the assassination of Archduke Franz Ferdinand of Austria on June 28, 1914 suddenly did.

"Cascades can therefore be regarded as a specific manifestation of the robust yet fragile nature of many complex systems: a system may appear stable for long periods of time and withstand many external shocks (*IP: indicative for its robustness*), then suddenly and apparently inexplicably exhibit a large cascade (*IP: indicative for its fragility*)." Watts argued, "that some generic features of cascades can be explained in terms of the connectivity of the network by which influence is transmitted between individuals." Specifically, Watts discussed "that global (i.e., very large) cascades can be triggered by exogenous events (shocks) that are very small relative to the system size," and the phenomenon that "global cascades occur rarely relative to the number of shocks that the system receives, and may be triggered by shocks that are a priori indistinguishable from shocks that do not."

The model Watts uses to research these typical dynamics "is motivated by considering a population of individuals each of whom must decide between two alternative actions, and those decisions depend explicitly on the actions of other members of the population. In social and economic systems, decision makers often pay attention to each other either because they have limited information about the problem itself or limited ability to process even the information that is available." I assume that these conditions also prevail regarding war decisions in the System. Decision makers of states responsible for war decisions ('war' or 'no war') also depend on their decisions and, to a high degree, on similar decisions by other states. "In other decision-making scenarios, such as in collective action problems or social dilemmas, an individual's payoff is an explicit function of the actions of others." "And in other problems still, involving say the diffusion of a new technology, the utility of a single additional unit – fax machine for example – may depend on the number of units that have already been sold. In all these problems, therefore, regardless of the details, individual decision makers have an incentive to pay attention to the decisions of others. In economic terms, this entire class of problems is known generally as binary decisions with externalities. As simplistic as it appears, a binary decision framework is relevant to surprisingly complex problems. To take an extreme example, the creation of a political coalition or an international treaty is unquestionably a complex, multifaceted process with many potential outcomes. But once the coalition exists or the treaty has been drafted, the decision of whether or not to join is essential a binary one (…) the factors involved in the decision may be many, but the decision itself can be regarded as binary."

I consider 'war decisions' as binary decisions with externalities and thresholds. A state is 'at war' or is 'not at war', and the consistency of war dynamics in the System during the 1495-1945 period suggest that 'units' (organizations that preceded state-structures) followed the same 'war logic.' War decisions are deliberate decisions because war (as an activity) requires extensive preparation, organization, and mobilization. Decision makers have to consider several conditions to calculate the costs, benefits, and risks involved. During the development of the System (1495–1945), war between states was also to a high degree formalized, emphasizing their binary nature.

(Security) issues and states are closely related: issues are defined by other states and by what position(s) they take regarding these issues. Because 'issues are states' and 'states are issues,' states strongly focus on the decisions of other states regarding these issues. I assume that war decisions not only are binary, but also qualify as 'binary decisions with externalities.' War decisions of states are, to a high degree, influenced by the positions of other states regarding the issues involved.

The extent to which decision makers are influenced by issues, rather than 'how' they are influenced, depends on the correlation length of the System; the correlation length of the System is a measure for the 'percolation' of issues in the System: The correlation length determines how far tensions and issues (can) spread through the System. If a certain network of issues percolates the whole System, all issues are one way or the other connected. When this cluster is triggered, the System produces a systemic.

"Both the detailed mechanisms involved in binary decision problems, and also the origins of the externalities can vary widely across specific problems. Nevertheless, in many applications that have been examined in the economics and sociology literature, the decision itself can be considered function solely of the relative number of other agents who are observed to choose one alternative over the other." This relative number defines the threshold of the decision maker.

"Because many decisions are inherently costly, requiring commitment of time or resources, the relevant decision function frequently exhibits a strong threshold nature: agents display inertia in switching states, but once their personal threshold has been reached, the action of even a single neighbor can tip them from one state to another."

"A particularly simple binary decision rule with externalities that captures the essential features outlined above is the following: An individual agent observes the current states (either 0 or 1) of *k* other agents, which we call its neighbors, and adopts state 1 if at least a threshold fraction of its *k* neighbors are in state 1, or else it adopts state 0. To account for variations in knowledge, preferences, and observational capabilities across the population of decision-making agents, both individual thresholds and also the number of neighbors (*k*) are allowed to be heterogeneous. First, each agent is assigned a threshold." "Next, we construct a network of agents, in which each agent is connected to *k* neighbors with probability *p(k)* and the average number of neighbors is *(k)* = z." "More formally, we say that agents are represented by vertices (or nodes) in a graph; neighboring vertices are joined by edges; *p(k)* is the degree distribution of the graph; and z is the average degree." "Although we shall continue to speak of an agent's neighbors, we should think of them simply as the set of incoming signals that are relevant to the problem at hand."

I argue that a similar model, namely a simplified representation of the structure of decision-making processes, is applicable to war decisions in the System. States are connected to an integral part of certain issues that concern their interests and, potentially, their survival. States and issues form networks. As explained, issues are defined by other states, such as their potential impact on the ability of states to fulfill certain basic requirements. Issues can be considered as states and vice versa. Issues without states do not exist in the System. Issues have a certain connectivity; the more states or other issues are connected to a particular issue (i.e., the more incoming signals an issue generates), the more connected this issue is.

States position themselves relative to issues.

States apply, mostly implicitly, thresholds that define when they also switch to positive war decisions. The number and properties of incoming signals that trigger a positive war decision define thresholds. Thresholds are properties of states. The thresholds that states apply, explicitly or implicitly, are a function of their basic requirements, perceived threats and tensions, and issues the state is connected with. Different states apply different thresholds, and the thresholds of particular states are dynamic. With respect to thresholds of states, the System qualifies as a heterogeneous network.

"In the social science literature, decision rules of this kind are usually derived either from the payoff structure of non-cooperative games such as the prisoner's dilemma, or from stochastic sampling procedures. But when regarded more generally as a change of state – not just a decision – the model belongs to a larger class of contagion problems that includes models of failures in engineered systems such as power transmission networks or the internet, epidemiological and percolation models of disease spreading, and a multiplicity of cellular-automata models including random-field Ising models, bootstrap percolation, majority voting, spreading activation, and self-organized criticality."

"The model, however, differs from these other contagion models in some important respects. Unlike epidemiological models, where contagion events between pairs of individuals are independent, the threshold rule effectively introduces local dependencies; that is, the effect that a single infected neighbor will have on a given node depends critically on the states of the node's other neighbors. Unlike bootstrap percolation, and self-organized criticality models (which also exhibit local dependencies), the threshold is not expressed in terms of the absolute number of a node's neighbors choosing a given alternative, but the corresponding fraction of the neighborhood. This is a natural condition to impose for decision-making problems, because the more signals a decision maker receives, the less significant any one signal becomes."

Over time, states and issues (and vice versa) become more connected, having the effect that any one new signal becomes less significant and furthermore requires more processing time to make sense of because of increased saturation of the regulatory capacity. "... we are concerned with heterogeneous networks; that is, networks in which individuals have different numbers of neighbors. All these features - local dependencies, fractional thresholds, and heterogeneity- are essential to the dynamics of cascades."

"Because building relationships and gathering information are both costly exercises, (*IP: as is also explained by Mattick et al.* (41)) interaction and influence networks tend to be very sparse – a characteristic that appears to be true of real networks in general – so we consider only the properties of networks with $z << n$. In the absence of any known geometry for the problem, a natural first choice for a sparse interaction network is an undirected random graph, with 'n' vertices and specified degree distribution *p(k).* Although random graphs are not considered to be highly realistic models of most real-world networks, they are often used as first approximations because of their relative tractability, and this tradition is followed here. Our approach concentrates on two quantities: (1) the probability that a global cascade will be triggered by a single node (or small seed of nodes), where we define a global cascade formally as a cascade that occupies a finite fraction of an infinite network; and (2) the expected size of a global cascade once it is triggered. When describing our results, the term cascade therefore refers to an event of any size triggered by an initial seed, whereas global cascade is reserved for sufficiently large cascades (in practice, this means more than a fixed fraction of large, but finite network)." "We call vertices that are unstable in this one-step sense, vulnerable, and those that are not, stable." Vulnerable vertices – 'unstable' states (unstable in the sense that they are one step from switching to 'war') – form 'vulnerable clusters'. Because 'states' and 'issues' are 'identical' ('states are issues and issues are states') I also refer to these clusters as 'vulnerable issue clusters': clusters of issues (= states) that have this one-step property.

Watts provides an example of the dynamics of a binary decision model with externalities: "Although the vulnerability condition is quite general, for concreteness we use the language of the diffusion of innovations, in which the initial seed plays the role of the innovators, and vulnerable vertices correspond to early adopters. Unless the innovators are connected to a community of early adopters, no cascade is possible."

"In fact, as we show below, the success or failure of an innovation may depend less on the number and characteristics of the innovators themselves than on the structure of the community of early adopters." "Clearly, the more early adopters exist in the network, the more likely it is that an innovation will spread. But the extent of its growth – and hence the susceptibility of the network as whole – depends not only on the number of early adopters, but on how connected they are to one another, and also to the much larger community consisting of the early and late majority, who do not tend respond to the innovators directly, but who can be influenced indirectly if exposed to multiple early adopters."

"In the context of this model, we conjecture that the required condition for a global cascade is that the sub network of vulnerable vertices must percolate throughout the network as a whole, which is to say that the largest, connected vulnerable cluster must occupy a finite fraction of an infinite network." "Regardless of how connected the network as a whole might be, the claim here is that only if the largest vulnerable cluster percolates are global cascades possible. This is called the 'cascade (*IP: or percolation*) condition'."

Watts argues that the cascade condition can be interpreted as follows: Below a certain value of 'Z', the early adopters (e.g., issues) are isolated from each other and will be unable to generate the momentum necessary for a cascade to become global. Above a certain level of 'Z', cascade conditions are met, thus implying that the largest vulnerable cluster has percolated, in which case random initial shocks can trigger global cascades.

However, it is not only the size, but also the frequency of cascades that are successfully triggered. This is related to the size of the underlying vulnerable component: "the larger this vulnerable cluster is, the more likely a randomly chosen initial site is to be a part of it."

In the case of the System, a 'percolation condition' exists (i.e. a condition that can produce a systemic war) when an issue network, or network of vulnerable states that are one step away from a positive war decision, has percolated the System. If this is the case, the correlation length of the System equals one, and the System is critical; that is, a positive war decision of a single state will trigger similar decisions in the whole network. This domino effect causes a system-wide cascade. Therefore, percolation conditions, criticality, a correlation length of one, and systemic wars go hand in hand. This mechanism demonstrates that is important, at least analytically, to make a distinction between the dynamics of the 'underlying' network of vulnerable issue clusters and the dynamics that are or can be generated on this network (e.g., wars). This distinction is related to another distinction I introduce later: the distinction between an 'underlying' deterministic domain and a contingent domain. Whereas the dynamics of this underlying network show remarkable regularities, the events that unfold on this network are, at least in many aspects, contingent. Watts explains, "… this condition, which we call the cascade condition has the considerable advantage of reducing a complex dynamics problem to a static, percolation problem that can be solved using a generating function approach." This mechanism shows that certain properties of the structure of the underlying network of states and issues, and the dynamics of this network, determine and shape the war dynamics on this network.

Historians and social scientists typically focus on the dynamics *on* the network of states and issues, as well as on events that occur in the contingent domain of the System. In fact, it is the dynamics of the underlying network (the deterministic domain) that determine and shape contingent events.

Watts' research (72) shows that global cascades can only occur when the connectivity and thresholds of nodes composing the network have values within certain boundaries. For cascades to emerge a minimum connectivity is required; alternatively, cascades become impossible when a certain maximum connectivity is reached. The connectivity and threshold values of the network determine the boundaries of the so-called 'cascade window.' Cascades are possible within this window and impossible outside of it.

It is possible to identify a 'war window' for the System; this window is limited by a lower and upper phase transition (72). War dynamics also require a minimum connectivity of the System to emerge. The minimum connectivity level of the System corresponds to the lower phase transition in Watts' model, and was reached in 1495. The upper phase transition was reached in 1939. At that stage, the connectivity of the anarchistic System reached a critical threshold, prohibiting (non-systemic) cascades. Because the connectivity of the System at that stage made cascades impossible, while at the same time tensions and free energy were building up in 'infinite' amounts, the System was forced to transit to a fundamentally different phase. As a consequence of its increasing connectivity, the anarchistic System (i.e., Europe) was in fact pushed out of the war window and forced to undergo a phase transition.

Simulations with Watts' model also show that, within the cascade window "global cascades can occur in two distinct regimes – a low connectivity regime and a high connectivity regime – corresponding to the lower and upper phase transitions respectively." In the low connectivity regime, "cascade propagation is limited by the connectivity of the network, a power law distribution of cascade sizes is observed, analogous to the cluster size distribution in standard percolation theory and avalanches in self-organized criticality." This means that the size of cascades in the low connectivity regime is determined by the connectivity of the network. When the connectivity increases, the size of cascades that the system produces also increases. However, at a particular stage, when a certain level of connectivity is reached, the size of cascades starts to decrease; cascade propagation now becomes limited not by a lack of connectivity, but instead by the local stability of the nodes themselves, which is caused by the increased connectivity of the network.

At that stage, due to the high connectivity, the effect of a new single signal becomes less significant.

This 'connectivity/local stability effect' can be explained with a simple example. If the threshold level of a state is determined to be 0.40, this means that this state will also switch to a positive war decision when 0.40 of the states that are connected to the issue concerned switch to war (regarding this issue). When 10 states are connected to this issue, of which three (or 0.30 states) are prepared to engage in war, an additional fourth state that switches to war will cause a switch to a positive war decision by the state that uses a threshold of 0.40. If, however, this particular state has 100 connections, of which 30 are prepared to engage in war (or 0.30 states), an additional positive switch of just one state will not cause such an effect. The higher level of connectivity produces a local stability effect in the network. 'Local' implies that the stability effect that is created through increased connectivity only concerns a particular issue and the states that are connected to this issue. If states become increasingly more connected, additional 'islands' of local stability emerge in the network. Ultimately, these multiple local stability effects produce a larger, and ultimately system-wide, effect. Multiple local stabilities caused by increased connectivity produce, at a certain point (e.g., at the critical connectivity threshold) system-wide stability and thus hamper non-systemic wars (release events) from taking place. These multiple local stability effects in fact deprive the System of a mechanism to regulate energy releases, causing a massive buildup of tensions and destructive energy. This build up pushes the System to criticality and causes a systemic war instead, thereby allowing for a massive energy (tension) release and a simultaneous reorganization of the System. As a consequence, the size distribution of cascades in a high connectivity regime is different compared to a low connectivity regime. In the high connectivity regime, "the size distribution of cascades is bimodal, implying a more extreme kind of instability that is correspondingly harder to anticipate (72)."

I define the point at which the network changes from a low to a high connectivity regime as the tipping point of the relatively stable period (international order) of the cycle. When the tipping point is reached, the local stability of states in the System starts to impact the size of non-systemic wars. From that moment onward, the size of non-systemic wars starts to decrease and multiple 'islands' of local stability emerge. This observation in the dynamics of Watts' model raises the question of whether it is also possible to distinguish between two regimes in the non-systemic war dynamics of the System during the successive life spans of relatively stable periods. Two regimes would point to the existence of a tipping point.

Data analysis reveals that this is indeed the case; two regimes, a low and high connectivity regime divided by a tipping point, can indeed be identified.

Watts in his model distinguishes between two 'phase transitions': respectively associated with the lower and upper boundary of the cascade window. These phase transitions have different characteristics. For the System, the lower phase transition occurred when the System in 1495 reached the lower boundary of the war window, in other words when the 'system' reached the percolation threshold and nodes - states- became sufficiently connected to produce system-behavior. The System reached the upper phase transition when in 1939 the System reached the critical connectivity threshold.

"The nature of the phase transitions at the two boundaries (*IP: the lower and upper boundary of the cascade window*) is different, and this has important consequences for the apparent stability of the systems involved", as simulations with Watts' model show: "the cumulative distribution of cascades at the lower boundary of the cascade window follows a power law, analogous to the distribution of avalanches in models of self-organized criticality or the cluster size distribution at criticality for standard percolation." "This result is expected because, when Z approximates 1, most vertices satisfy the vulnerability condition, so the propagation of cascades is constrained principally by the connectivity of the network." The dynamics at the upper boundary, however, are different: "Here, the propagation of cascades is not limited by the connectivity of the network (*IP: as is the case at the lower boundary*), but by the local stability of the vertices." "Most vertices in this regime have so many neighbors that they cannot be toppled by a single neighbor perturbation: hence, most initial shocks immediately encounter stable vertices. Most cascades therefore die out before spreading very far, giving the appearance that large cascades are exponentially unlikely." I have already explained this connectivity/local stability effect in this chapter.

However, when the System reaches the upper phase transition (a critical point, as happened four times during its life span) a percolating vulnerable cluster keeps developing because due to continuous growth in connectivity of the issue network and accompanying tensions. When the upper boundary (the upper phase transition) of the war window is reached, the local stability of the network makes that "only very rarely a cascade will be triggered, but in which case the high connectivity of the network ensures that it will be extremely large, typically much larger than cascades at the lower phase transition. The result is a distribution of cascade sizes that is bimodal rather than a power law."

Regarding the cascade dynamics when the upper phase transition is being reached, Watts observes that "just inside the boundary of the window, where global cascades occur very rarely, the system will in general be indistinguishable from one that is highly stable, exhibiting only tiny cascades for many initial shocks before generating a massive, global cascade in response to a shock that is a priori indistinguishable from any other."

A closer look at the non-systemic war dynamics of the System, shortly before the upper phase transition of the war window was reached (four times, shortly before the System became critical and produced systemic wars as a consequence), shows that the non-systemic war dynamics at that point were consistent with the cascade dynamics in Watts' model. Similar to Watts' model the System at that stage was remarkably robust. This typical development—that is a decrease in the non-systemic war dynamics preceding a systemic war—was especially evident before the outbreak of the third systemic war (the First World War, 1914-1918) when the relative stability of the System was even interpreted as a sign that war had become impossible.

However, as the outbreak of the First World war (the third systemic war, 1914-1918) shows, it was just a matter of time before a relatively minor incident (i.e., the assassination of Archduke Franz Ferdinand in Sarajevo, June 1914), which was 'indistinguishable from any other,' triggered the underlying percolated vulnerable issue cluster and generated a massive global cascade (that became the third systemic war of the System).

Cascade(s)

Cascades – war cascades – the System produces can be understood as domino effects. Cascades – domino effects – are 'cumulative' effects, when a decision of one state to 'go to war', sets off a chain of similar decisions by other states. War cascades – domino effects – in the System are 'regulated' by the connectivity of the issue-network.

Cascade or percolation condition

When a (underlying) vulnerable issue cluster percolates the System, the System reaches a 'cascade (or percolation) condition' and has become critical.

In the case of the System, a cascade or percolation condition exists (i.e., a condition that can produce a systemic war) when an issue network, or network of vulnerable states that are one step away from a positive war decision, has percolated the System. If this is the case, the correlation length of the System equals one, and the System is critical; that is, a positive war decision of a single state will trigger similar decisions in the whole network. This domino effect causes a system-wide cascade. Therefore, percolation conditions, criticality, a correlation length of one, and systemic wars go hand in hand.
See also: *Cascade dynamics, cascades triggered by shocks.*

Cascade (war) window

Watts' research (72) shows that global cascades can only occur when the connectivity and thresholds of nodes composing the network have values within certain boundaries. For cascades to emerge a minimum connectivity is required; alternatively, cascades become impossible when a certain maximum connectivity is reached. The connectivity and threshold values of the network determine the boundaries of the so-called 'cascade window.' Cascades are possible within this window and impossible outside of it.
See also: *War window* and *Cascade dynamics, cascades triggered by shocks.*

Cast
With cast I refer to the 'selection' of main characters, that happen to play a (major) role in the contingent dynamics of the System. Churchill, Hitler, Roosevelt and Stalin were the 'cast' of the fourth systemic war (the Second World War, 1939-1945). As long as the deterministic requirements are met, the System 'does' not care about the cast, and the specific issues they produce, and promote.

Causal loop diagram (CLD)
Causal loop diagrams are maps that show causal links among variables with arrows from a cause to an effect. A plus (+) denotes a positive relationship, while a minus (-) denotes a negative relationship between variables (69).

Centrality of states
The centrality of states in the network of issues and states in the System concerns their Great Power status. High centrality implies Great Power status in the contingent domain of the System. The connectivity of states, in combination with their potential to produce and deploy destructive energy, determine their degree of centrality in the System. States with a high centrality are more powerful and influential. During relatively stable periods the centrality of states evolves, it can either become lower or higher. These changes are however not (yet) embedded in the rule-sets that determine and shape – regulate – (inter)actions of and between states in the System. During systemic wars, when international orders are upgraded, these rule-sets are updated to ensure that they reflect the actual power positions of central states (Great Powers) in the System. These 'corrections' contribute to the structural stability of these upgraded international orders; states with a high centrality have a particular interest in ensuring that the new (upgraded) status quo is maintained.

Chaos, chaotic dynamics
"Chaos is a phenomenon encountered in science and mathematics wherein a deterministic rule-based system behaves unpredictably. That is, a system, which is governed by fixed, precise rules, nevertheless behaves in a way that is, for all practical purposes, unpredictable in the long run" (23). Chaotic systems are deterministic systems that appear to be random. However, they actually follow precise (mathematical) rules (51). Thus, "behind the veil of apparent randomness, though, many processes are highly ordered, following simple rules" (20). "Mathematically chaotic systems are, in a sense perfectly ordered, despite their apparent randomness." "The study of chaos shows that simple systems can exhibit complex and unpredictable behavior. This realization both suggests limits on our ability to predict certain phenomena and that complex behavior may have a simple explanation" (23).
A dynamical system is chaotic if it possesses each of the following properties (23):

1) The dynamical rule is deterministic.
2) The orbits are aperiodic, i.e., they never repeat.
3) The orbits are bounded and thus remain between an upper and lower limit.
4) The dynamical system has sensitive dependence for initial conditions. A system that has sensitive dependence for initial conditions has the property that a very small change in its initial conditions will lead to a very large change in orbit in the phase state.

Chaos requires a system with only a few – but at least three – so-called degrees of freedom or variables, but not too many. Chaotic dynamics rely on the assumption that only a few major variables interact nonlinearly and create complicated trajectories (63). From a mathematical perspective, the fact that chaotic dynamics are deterministic implies that the output of a deterministic function that describes the behavior of the chaotic dynamics is used as the input for the next step, which can be thought of as a feedback process in which output is used as input.

Sterman (69) defines chaotic dynamics from a system dynamics perspective as follows: "Chaos, like damped fluctuations and limit cycles, is a form of oscillation. However, unlike limit cycles, a chaotic system fluctuates irregularly, never exactly repeating, even though its motion is completely deterministic." "The irregularity arises endogenously and is not created by external, random shocks. Like a limit cycle, the path of a chaotic system is bounded to a certain region in state space. Because chaotic systems are bounded, chaos, like limit cycles, can only arise in nonlinear systems. However, unlike linear systems or limit cycles, chaotic dynamics do not have a well-defined period. The motion of a chaotic system never repeats; instead, the orbits of the system approach what is known as strange attractor, a set of closely related but slightly different orbits rather than a single closed curve. Furthermore, chaotic systems have the property known as sensitive dependence on initial conditions. Two nearby trajectories, no matter how close, will diverge exponentially until the state of one provides no more information about the state of the other than any randomly chosen trajectory. Sensitive dependence means that the prediction horizon for chaotic systems, the length of time over which forecasts of future behavior are accurate, is likely to be short even if our model of the system structure and parameter estimates are perfect."

This study shows that two types of non-systemic war dynamics can be distinguished: chaotic- and non-chaotic non-systemic war dynamics. 'Normally' - I argue - non-systemic war dynamics are chaotic in nature; however, it is not possible to scientifically prove that war dynamics are chaotic in this mathematical sense, since (for one reason) insufficient data is available.

This study shows that the nature of non-systemic war dynamics – chaotic or non-chaotic – is determined by the number of degrees of freedom (n) of the anarchistic System: in case $n > 2$, war dynamics are chaotic in nature; if $n = 2$ non-systemic war dynamics are periodic (as was the case during the first exceptional period, 1657-1763), or subdued (as was the case during the second exceptional period (1953-1989). The intensities of rivalries between Great Powers determine the number of degrees of freedom of the System. In case of the first and second exceptional period, the number of degrees of freedom of the System was temporarily decreased as a consequence of the intense rivalry between respectively Britain and France, and between The United States and the Soviet Union.

During the first exceptional period (1657-1763), non-systemic war dynamics were periodic (two subcycles can be distinguished), often extreme (in size and severity), and 'hyper-excited'. I attribute the extreme and hyper-excited nature of non-systemic war dynamics to a lack of 'inhibition' of the System's non-chaotic war dynamics; as a consequence of a lack of a third – balancing – degree of freedom. During the first exceptional period, not only produced the System extreme tensions, but they were also 'immediately' released.

The System can only charge for systemic wars during high-connectivity regimes and in case of chaotic (more inhibited) non-systemic war dynamics: 'chaos is a precondition for systemic war'.
See also: *Oscillation(s)*.

Chaotic behavior (regime) in Boolean networks
Kauffman identified 'chaotic regimes' in Boolean networks (36). A random Boolean network produces chaotic behavior when certain conditions are met. Kauffman observed that Boolean networks "as K decreases from K = N to K = 2" are "initially in the chaotic regime but undergo a sudden transition to ordered behavior when K = 2." Moreover, "evidence is found for a phase transition between the behavior of K = 2 Boolean networks and K > 2 networks." In other words, Kauffman suggests that 'the edge of chaos' is at the critical point between K = 2 and K > 2. These observations (regarding Boolean network dynamics) are consistent with my own observations regarding the war dynamics in the System.

Kauffman explains that K = 2 networks (implying non-chaotic dynamics) exhibit such profound order because "such networks develop a connected mesh, or frozen core, of elements, each frozen in either the 1 (active) or the 0 (inactive) state. The frozen core creates spanning, or percolating, walls of constancy, which break the system into functionally isolated islands of unfrozen elements cut off from influencing one another by the walls of frozen elements. The formation of such functionally isolated islands by a percolating frozen core appears to be a sufficient condition for order in Boolean networks; conversely, failure of a frozen core to percolate and leave functionally isolated unfrozen islands is a sufficient condition for chaos." "The boundary regime where a frozen core is just percolating and, more important, the unfrozen region is just breaking into unfrozen islands is the phase transition between order and chaos." The boundary regime is, in other words, the complex regime at the 'edge of chaos,' when the system is in a critical condition. Kauffman suggests that random Boolean networks at the 'edge of chaos' (i.e., at the critical point; in a critical condition) optimize certain functions, including their evolvability.

Kauffman's 'optimization hypothesis' is consistent with similar observations and assumptions by Bak et al. and Beggs et al. regarding the class of SOC-systems and the dynamics of the human brain, respectively (3), (4), (5), (10). Certain functions of these systems also seem to be optimized at the critical point, such as energy redistribution in sand piles and information processing in the brain. Kauffman's framework, in combination with the hypotheses of Bak et al. and Beggs et al., is useful to further investigate if the System also optimizes certain functions at the critical point (that is, during systemic wars).

See also: *Regimes of behavior of Boolean networks.*

Chaotic non-systemic war dynamics, indicators

A number of indicators point to the chaotic nature of non-systemic war dynamics. These indicators include: (1) circular trajectories (orbits) in phase state (defined by the size and intensity of non-systemic wars), (2) the existence of positive Lyapunov exponents, (3) a lack of auto-correlation in non-systemic war dynamics, except for an temporary increase in auto-correlation that can be observed during the first exceptional period (1657-1763), when I assume, non-systemic war dynamics were non-chaotic in nature, and (4) of the consistency of the frame-work (including the assumption that non-systemic war dynamics are chaotic by default) presented in this study.

Charging

With the term 'charging' I refer to the dynamics of the anarchistic System during high-connectivity regimes of relatively stable periods (international orders).

As a consequence of the connectivity/local stability-effect during high-connectivity regimes, instead of being released, free energy (tensions) is increasingly 'stored' in the System, form a 'free energy release deficit', and crystalizes into vulnerable issue clusters that will eventually percolate the System, cause it to become critical and produce a systemic war. Through systemic wars the System periodically upgrades its order to allow for a lower energy state of the System, to ensure compliance with the second law of thermodynamics.

The current relatively stable periods (international order 1945-...) is now in its high-connectivity regime and charging for the next systemic war. This study suggests (assuming the extended war data set is correct) that the System will become critical again in 2020 and produce a systemic war (2020-2036).

See also: *High-connectivity regime* and *Connectivity/local stability-effect.*

CINC-index

CINC-index stands for the 'Composite Index of National Capability', and is based on six variables: (1) total population, (2) urban population, (3) iron and steel production, (4) energy consumption, (5) military personnel, and

(6) military expenditure. CINC is s statistical measure of national power; its components represent demographic, economic and military strength. Each component (out of six) is a percentage of the word's total: Component ratio = state / global; the CINC (by state) = the sum of the six ratios / 6 (59).

Clausewitz's war theory 'On War'
Clausewitz's adagio: '*War is a mere continuation of politics (policy) by other means*' (19) points to the instrumentality of war, and, from the perspective of this study, to the inseparable link between states and their functionality in ensuring the fulfillment of basic requirements and survival of their populations in an anarchistic System.

Clausewitz's war and politics theory concerns the dynamics in the contingent domain of the System and is a component of interacting self-fulfilling prophecies that ensure justification of the deployment of ever-increasing levels of destructive energy.

Coevolution, co-evolutionary process
The development of states (units of the System) and of successive international orders during the unfolding of the finite-time singularity dynamic (1495-1945) constitutes a co-evolutionary process: the development of the state affected the development of successive international orders, and vice versa.

A 'powerful-become-more-powerful' mechanism was instrumental in this process: Through systemic wars, dominant states could ensure that (upgraded) international orders especially supported their interests and positions in the System. These privileges further increased their power and influence, they could put to use during the next systemic war, etc.
See also: *Powerful-become-more-powerful effect*.

Composite Index of National Capability (CINC-index)
The Composite Index of National Capability (CINC) The Composite Index of National Capability (CINC) is a statistical measure of national power (59). It uses an average percentage of world totals in six different components. The components represent demographic, economic, and military strengths. The CINC-index measures 'hard' power, but does not include soft power, and for that reason may not represent total national power.

Conflict prevention and control

1 *Introduction*
In this section I briefly discuss how this study could contribute to conflict prevention and control. However, given the fact that wars are intrinsic to anarchistic systems, I am skeptical to what extent conflicts can actually be prevented and controlled within anarchistic systems; interacting self-fulfilling prophecies make that states – especially Great Powers – lack sufficient mutual trust and can always justify their (war) decisions.

In order to prevent war, its causes must be addressed; wars are symptoms of 'underlying' dynamics of anarchistic systems.

Until now, conflict prevention and control solely focused on dynamics and interactions in the contingent domain of the System; the existence of a deterministic domain, let alone its impact on contingent dynamics, was not yet recognized. For this reason, conflict prevention and control research is incomplete and in some cases misguided. It is obvious that the deterministic domain provides not only practical and meaningful early warning signals, but also useful clues to develop more effective conflict prevention and control measures (at least in theory).

Much conflict control and prevention research originates in the Cold War and focuses in particular on rivalries between the United States and the Soviet Union (and the hierarchies they controlled). These rivalries led to the preventive deployment (not use) of huge amounts of destructive energy on both sides, which could have resulted in collective self-destruction if actually deployed.

In this section I discuss a number of observations and suggestions by Boulding, he explains in the book '*Conflict and Defense, A General Theory*' (15). Boulding defines conflict as "a situation of competition in which parties are aware of the incompatibility of potential future positions and in which each party wishes to occupy a position that is incompatible with the wishes of the other." Boulding's general theory also applies to wars between states.

2 *Procedural conflict resolution*

Boulding distinguishes three methods of ending conflicts: (1) avoidance (for example, through an increase in physical or social distance), (2) conquest, and, if "parties can neither conquer nor avoid each other," (3) some form of procedural resolution. In the case of procedural resolution, "the parties have to stay together and live with each other." All three methods are still applied in the System to end and avoid war.

Boulding further distinguishes three types of procedural conflict resolution: "The *first* is reconciliation, in which the value systems of the images of the parties so change that they now have common preferences in their joint field... The *second* is compromise, in which the value systems are not identical and the parties have different optimum positions in the joint field, however, each party is willing to settle for something less than his ideal position rather than continue the conflict. In compromise, this settlement is reached mutually by bargaining between the parties themselves. The *third* type of conflict conclusion is award, in which a settlement is reached because both parties have agreed to accept the verdict of an outside person or agency rather than continue the conflict. The compromise and the award are essentially similar in that they both represent less than the ideal situation for each party; they differ mainly in the method of arriving at the settlement."

States in anarchistic systems – or alliances and coalitions they form - are more or less continuously in a state of potential conflict. The paradox of the System during the unfolding of the finite-time singularity dynamic (1495-1945) is that while states became increasingly dependent on each other for the fulfillment of their basic requirements, including their security, they simultaneously became prone to conflict; this concerns the intrinsic incompatibility between connectivity and security in anarchistic systems, as discussed in this study.

An international order can be considered a shared 'compromise sphere,' a form of procedural conflict resolution that is instrumental in ensuring the fulfillment of basic requirements of uneven states in an anarchistic System; conquest and avoidance are not useful or achievable. The arrangements of international orders are necessary compromises that however need periodic adjustment to re-align the System's order with the changing interests and power positions of its states because of the continuously increasing connectivity of the System (and its effects).

The fact that there is permanent latent and manifest conflict between states in anarchistic systems is related to their sovereignty. They must compete for scarce resources because in an anarchistic system they are ultimately responsible for their own security and survival. Furthermore, relationships between states and their power and influence positions are constantly changing as a consequence of population and connectivity growth and the resultant increasing rivalry between states; this is also a factor that contributes to permanent conflict in the System.

Boulding observes: "One of the great organizational problems of mankind, then, is the control of violence or, more generally, the control of conflict to the point where procedural institutions are adequate to handle it." This was ultimately achieved in Europe through the implementation of dedicated hierarchies, and their merging (however the sustainability of the process of integration it implies still is crystalizing/unfolding). "The great course of political evolution, from the family to the tribe to the nation to the superpower, and, finally one hopes, to the world government now [*IP: in 1962*] in its birth pangs is testimony to the ability of human organization to extend conflict control to wider and wider human areas."

Boulding notes, "it is hardly too much to say that conflict control is government, and though government has broader functions than this, conflict control is perhaps its most important single task - the one thing which it must perform or cease to be government...

"It is easy to see that the institutions that might have prevented the two world wars were simply not present; it is more difficult to specify the institutions that will prevent a third, a possibly last, world war. Our knowledge of the dynamics of conflict processes is still primitive. Just as government efforts to prevent a business cycle may actually intensify it if poorly planned and badly timed, so efforts at conflict control may intensify the very conflicts that they are intended to control if they are based on too inaccurate knowledge of the social systems involved... in the attempt to control conflicts we shall make many mistakes, the successes will outweigh the failures."

This study shows that Boulding's observations are not (in all respects) correct. Prevention of systemic wars in anarchistic systems is impossible, as long as these systems produce free energy; the free energy will be put to work as a matter of time, to ensure compliance with the second law of thermodynamics. Systemic wars are intrinsic dynamics of anarchistic systems, and instrumental in computing and designing optimal structures and accompanying institutions to ensure compliance with the second law of thermodynamics. Anarchy and (systemic) wars are closely related phenomena. This study suggests that systemic wars produce optimal structures and institutions, that ensure optimal performance and evolvability of the System; 'we' cannot do better given the conditions of the System and the laws that apply to the (application of) free energy the System produces.

Boulding suggests that "business cycles" are similar to war cycles; governments try to control business cycles and dampen their negative effects by adjusting financial and economic measures. Apart from the question of how effective governments are in achieving this, it is useful to further explore such an approach. I, however, am skeptical. The unfolding self-organized finite-time singularity that constitutes a powerful self-reinforcing dynamic cannot be tamed, let alone stopped, by measures that address neither the intrinsic incompatibility between connectivity and security in an anarchistic System, nor the fact that states are designed to fight wars.

3 *Designing effective measures to prevent and control conflicts*

Effective conflict prevention and control requires understanding of the dynamics of the System. Until now, research, including Boulding's, focused exclusively on dynamics in the contingent domain of the System; there was no awareness that the dynamics in the contingent domain are, to a high degree, shaped by an underlying deterministic domain and its accompanying dynamics that determine a number of key properties of contingent dynamics, including the timing, duration, and severity of systemic wars.

Prevention and control must focus on the workings of the underlying deterministic dynamics; in the deterministic domain, clues must be found to make conflict prevention and control more effective. The fact that certain properties of the dynamics of the System, especially systemic wars, can now be predicted provides numerous clues and opportunities to design and implement effective measures to prevent and control conflicts. Clues for effective conflict prevention and control include: population growth, the nature of decision making, and the second law of thermodynamics and other laws and mechanisms that demand the periodic upgrade of orders.

Boulding was well aware in 1962 of shortcomings in the methods for conflict resolution that had been developed. Boulding explains: "The problems of organization and of bargaining involved in setting up the institutions of arms control and, more generally, of international conflict control are difficult indeed; but it would be suicide for the human race to believe that they are insoluble. It has been the major theme of this work to show that conflict processes are not arbitrary, random, or incomprehensible. In the understanding of these processes lies the opportunity for their control, and perhaps even for human survival.

"We cannot claim that our understanding is deep enough, and much work yet needs to be done, but it can and must be claimed that the understanding and, therefore ultimately, the control of these processes is possible."

With the new insights this study provides, it must be possible to identify measures – including conditions that must be achieved – and design structures that allow (at least in theory) for effective conflict prevention and control. However, this study also shows that the self-organized and intrinsic nature of war dynamics in anarchistic systems cannot be managed: each measure is – or becomes - an integral part of the System's (war) dynamics as a matter of time.

Boulding further observes: "The two greatest problems of control systems are first, signal detection, that is, how do we know when something needs to be done, and second, implementation, or how do we know what to do... The problem is how to detect social situations that are in the early stages of a process that will lead eventually to destructive conflict if it is not checked."

As discussed and shown in this chapter, it is possible to identify a number of deterministic and contingent indicators to assess the condition of the System and predict some of the deterministic properties of its war dynamics.

The two domains synchronize their dynamics through interacting self-fulfilling prophecies of states. Interacting self-fulfilling prophecies produce and shape issues that act as attractors around which vulnerable issue clusters crystallize. Free energy-carrying tensions that the System produces obey the inescapable second law of thermodynamics and a number of other laws and deterministic mechanisms that determine and shape war dynamics.

Because of the large impacts of the deterministic domain on contingent dynamics of the System, a control system must – to begin with - determine and monitor deterministic properties of the System. Deterministic indicators can be considered a framework in which contingent dynamics and events occur and evolve: This framework defines the latitude – the playing field – for contingent dynamics of the System.

A control system must, in other words, combine what could be called a 'top-down' (deterministic) perspective with a 'bottom-up' (contingent) perspective. The top-down perspective predicts when systemic wars can be expected, their duration, and how much destructive energy will be released. The bottom-up perspective complements the top-down perspective (and vice versa) and focuses on (1) the self-reinforcing feedback loops that are integral parts of interacting self-fulfilling prophesies and (2) the crystallization, connectivity, and growth of underlying vulnerable issue clusters and accompanying tensions (free energy).

Competition, conflict and war

Boulding in the study *Conflict and Defense, A general Theory* (15) explains the differences between competition, conflict and war, and makes a number of observations that are confirmed by this study.

Boulding studies "… conflict as a general social process of which war is a special case." According to Boulding competition, conflict and war are related concepts.

"Competition in its broadest sense exists when any potential positions of two behavior units are mutually incompatible. This is a broader concept than conflict… in the sense that, whereas all cases of conflict involve competition, in the above sense, not all cases of competition involve conflict.

Two positions are mutually incompatible if each excludes the other, that is, if the realization of either one makes impossible the realization of the other. … The intensity of competition depends on the likelihood of each behavior unit moving into the incompatible space…".

"Conflict may be defined as a situation of competition in which the parties are aware of the incompatibility between potential future positions and in which each party wishes to occupy a position that is incompatible with the wishes of the other".

Regarding the dynamics of conflict, Boulding observes: "One of the great problems in social dynamics is that dynamic systems are not stable and are frequently subject to unpredictable change. Nevertheless, the succession of states of a social system is not random; some regularities can usually be detected… … Where the dynamics of the system results in a succession of identically similar states, the system is said to be in equilibrium… some do not… and move toward system breakdown, some point at which the laws of the system change".

"One of the most striking differences between the conflict of firms and of states … is that the competition of states is marked by a dramatic alteration of peace and war. This alteration of two contrasted forms of conflict – covert conflict of threats, promises, and pressures during peace and overt conflict in war – is not confined to international relations…".

"Nevertheless, the covert-overt pattern as a standard and most regular cycle is found in its most developed form in international relations. Clausewitz's famous remark that war is an extension of diplomacy is a recognition both of the unity of the system of diplomacy and war and of its two sharply contrasted patterns. What we have really is two systems – one, diplomacy, and the other war – each of which moves to a point where it gives rise to the other, so that we have a constant though not necessarily regular alternation between them."

Complex regime

See: *Regimes of behavior of Boolean networks.*

Complex system
Complex systems are systems that exhibit self-organized – emergent – order (organization) in their dynamics and structures.
See also: *Self-organization*.

Connectivity of the network/System
With connectivity of the network/System I refer to two different (but related) networks: to (1) the connectivity of the 'overall' network/System, related to its population size and to population growth, and (2) the connectivity of the network of issues and states, and accompanying tensions. Population growth, and the need for humans and social systems to fulfill basic requirements, drive the connectivity of the 'overall' network/System. The intrinsic incompatibility between connectivity (interdependence) and security in anarchistic systems (and related 'mechanisms', like rivalries between states, the security dilemma, interacting self-fulfilling prophecies, etc.) drive the connectivity of the issue network and the connectivity of the network of underlying vulnerable issue clusters.

Population size (concerning the overall network/System), determine the System's pace of life; the degree of connectivity of the issue network determines if relatively stable periods (international orders) are in a low-or high-connectivity regime. Both networks are related.

The main properties of the 'two' networks that determine and shape the System's war dynamics and development

Property	Overall network/System	Network of issues and vulnerable issue clusters
Connectivity	Determined by population size.	Determined by tension levels during relatively stable periods.
Driver of connectivity growth	Population growth, and the fulfillment of basic requirements.	Incompatibility between increasing connectivity and security in anarchistic systems.
(Main) impact of connectivity	The pace of life of the System. The pace of life of the System determines (for example) the spreading speed of tensions in the System, and the life-span of cycles.	The regime of the System during relatively stable periods: a low- or high connectivity regime. The regime determines the size and frequency of non-systemic wars.

Table 125 *In this table the main characteristics of the two networks that determine and shape the dynamics and development of the System are shown.*

Connectivity/security-incompatibility
Connectivity and security are incompatible in anarchistic systems: increasing connectivity of the System results in increasing levels of free energy and insecurity (issues, tensions, rivalries) in respectively the deterministic and contingent domains of the System.

In an anarchistic system each (new) connection provides (or could provide) certain 'advantages' (positive effects), but is always accompanied by (potential) security issues and tensions. Each connection brings – so to say – opportunities and risks.

Connectivity/local stability effect

Increasing connectivity of the System during relatively stable periods (international orders) at a certain point – when the tipping point is reached – produces a 'local' stability effect in the System. 'Local' implies that the stability effect that is created through increased connectivity concerns particular issues and states that are connected to this issue. If states become increasingly more connected, additional 'islands' of local stability emerge in the network. Ultimately, these multiple local stability effects produce a larger, and ultimately system-wide, effect. Multiple local stabilities caused by increased connectivity produce, at a certain point (e.g., at the critical connectivity threshold) system-wide stability and thus hamper non-systemic wars (release events) from taking place. These multiple local stability effects in fact deprive the System of a mechanism to regulate energy releases, causing a massive buildup of tensions and destructive energy. This build up pushes the System to criticality and causes a systemic war instead, thereby allowing for a massive energy (tension) release and a simultaneous reorganization of the System. The size distribution of non-systemic wars during high connectivity regimes is different compared to size distributions during low connectivity regimes. See also: *Charging*.

Consistency index

I introduced a – what I call – consistency measure to acquire an indication of the consistency of the actual finite-time singularity dynamic (1495-1945), and an undisturbed – corrected – version I constructed (see also part II). Based on the analysis of the finite-time singularity dynamic it is possible to identify 11 properties of the dynamic. I assume that causal relationship exists between these variables (properties), and that all these properties are more or less determined/shaped by the connectivity of the System; these 11 properties result in 55 correlation coefficients. I consider the average of these 55 correlation coefficients a measure for the consistency of the singularity dynamic. The consistency measure of the actual singularity dynamic is 0,78 and the consistency measure of the theoretical model is 0,90.

Contingent, contingent system, contingent domain

See: *Deterministic, deterministic system, deterministic domain*.

Contingent latitude

Although the deterministic domain determines the dynamics and development of the System, some 'latitude' is left for contingent dynamics (the contingent domain); in principle 'all' contingent dynamics are possible ('allowed') as long as they do not conflict with – infringe on – deterministic laws. Free energy produced in the deterministic domain, results in contingent issues and tensions (and contingent dynamics), within the 'contingent-latitude' allowed by the deterministic domain. So to say: deterministic constraints + contingent latitude = contingent dynamics.

Control parameter

A control parameter determines the dynamics – behavior – of a system. Connectivity is a control parameter of the System, and determines – 'drives' – its dynamics, and defines a number of its properties, including: its robustness, fragility and pace of life.
See also: *Order parameter*.

Correlation length

The correlation length measures the characteristic distance with which the behavior of one element of the system is correlated with or influenced by the behavior of another element.

The correlation length in the System is the size of largest vulnerable issue cluster.

At the critical point, the correlation length of the System is 'one'; the vulnerable issue clusters at the critical point spans the System. Because the correlation length at the critical point is one, the system at that point is highly susceptible for perturbations, that can propagate through the whole system.

Criticality enables system-wide communication, coordination and planning; properties that are 'used' by the System during systemic wars to collectively design and implement (system-wide) upgraded orders.

Jensen (32) explains the term correlation length as follows: "The nature of the critical state is described by the response of a system to external perturbation. For systems exhibiting noncritical behavior, the reaction of the system is described by a characteristic response time and characteristic length scale over which the perturbation is felt spatially. Although the response of a noncritical system may differ in detail as the system is perturbed at different positions and at different times, the distributions of responses is narrow and well described by the average response. For a critical system, the same perturbation applied at different positions or at the same position at different times can lead to a response of any size. The average may not be a useful measure of the response; in fact, the average might not even exist."

Critical condition of the System

When the System reaches a critical point, it is in a critical condition. Systemic wars in the System are manifestations of the System's criticality. During criticality, the correlation length of the System is one, implying that issue- and war clusters have percolated the System. A correlation length of one (criticality) enables system-wide communication, coordination and planning. When the System is critical, it is highly susceptible for perturbations, that can then propagate through the System. During systemic wars, the System uses critical properties to collectively design and implement system-wide upgraded orders.

Critical connectivity threshold

Connectivity and security are intrinsically incompatible in anarchistic systems and result in the production of free energy (tensions). As a consequence of population growth in states, the connectivity of the System also increases. During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles, the anarchistic System produced free energy (tensions) at an accelerating rate. Accelerating growth rates are unsustainable.

In 1939 the core of the anarchistic System (Europe) reached the critical connectivity threshold (the singularity in finite time), and produced 'infinite' amounts of free energy, that had to be put to work at an infinite rate to ensure compliance with the second law of thermodynamics. This unsustainable condition (requiring infinite amounts of destructive energy deployment, causing 'infinite' destruction) resulted in a collapse of the core of the anarchistic System, and a phase transition to ensure compliance with the second law of thermodynamics.
See also: *Anarchistic end state.*

Critical fraction

This study shows that the anarchistic System – through a finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) – developed a very regular (and predictable) pattern. Each cycle consists of a relatively stable period (international order) followed by a systemic war (a short critical period). Each relatively stable period consists of a low-connectivity regime, followed by a high-connectivity regime, divided by a tipping point.

During high-connectivity regimes, states in the System become increasingly (locally) stable; as a consequence, free energy (tensions) is not released, but stored in the System, and crystalizes in vulnerable issue clusters. The moment the vulnerable issue clusters percolate the System, the System becomes critical and produces a systemic war. During systemic wars the 'stored' tensions are released, and used (put to work) to upgrade the order of the System.

Typically, the sizes of non-systemic wars during high-connectivity regimes decrease quite regularly – tensions are not released but stored – to almost 'zero'.

However, at a certain point – what I name – the 'critical fraction' of non-systemic wars during high-connectivity regimes - the System 'abruptly becomes critical and produces a system-wide systemic war.

The critical fraction is the average size of five successive non-systemic wars.

The first finite-time singularity dynamic shows that the critical fraction is within a range of 0.17 and 0.30 (size in terms of fraction).
See also: *Early Warning Signal(s).*

Criticality

"The word criticality has a very precise meaning in equilibrium thermodynamics: It is used in connection with phase transitions" (see also the previous sections). At a specific transition value of the control parameter, a local distortion of the system not only influences the local neighborhood, but also propagates throughout the entire system. "The system becomes critical in the sense that all members of the system influence each other" (32).

Criticality of the anarchistic System – systemic war in the contingent domain – is a consequence of the inability of the anarchistic System during high-connectivity regimes of relatively stable periods to release free energy (tensions); this phenomenon I attribute to the connectivity/local stability effect.

During high-connectivity regimes of relatively stable periods, instead of being released free energy (tensions) is 'stored' in the System, and forms a 'free energy release deficit', that crystallizes in vulnerable issue clusters with fractal structures. The moment the vulnerable issue clusters percolate the System, and cause it to become critical, the System produces a systemic war. During a systemic war the free energy (tensions and unresolved issues) that are 'stored' in the free energy release deficit, is put to work to implement un upgraded order that enables a lower energy state of the System.

During systemic wars the System makes 'use' of its critical properties: because at a critical point the System's correlation length is one, system-wide communication, coordination and planning are 'enabled'. These critical properties make it possible for states to collectively design and implement upgraded (system-wide) orders through systemic wars.

Criticality, Functionality of

I argue that critical points (systemic wars) are instrumental in the process of rebalancing (i.e., implementing upgraded orders) in the System. The System puts free energy to work to accomplish this. I argue that criticality is a prerequisite to achieve a system-wide reorganization: Global reorganization requires system-wide communication, coordination, and planning. Without these system properties a new system-wide order cannot collectively be designed and implemented.

Upon closer inspection, it becomes clear that systemic wars are highly optimized and efficient activities where the anarchistic system – despite the selfish orientation of states – is able to produce 'upgraded' orders that at least temporarily (until the next critical period), meet the requirements of all states in the System. I discuss the highly optimized nature of systemic wars and of the finite-time singularity dynamic they were integral components of in previous parts.

Other systems, like the brain, as Beggs et al. (10) argue also seem to 'use' criticality to perform certain functions.

Beggs et al. argue that "Relatively recent work has reported that networks of neurons can produce avalanches of activity whose sizes follow a power law distribution. This suggests that these networks may be operating near a critical point, poised between a phase where activity rapidly dies out and a phase where activity is amplified over time. The hypothesis that the electrical activity of neural networks in the brain is critical is potentially important, as many simulations suggest that information processing functions would be optimized at the critical point."

"Criticality is a phenomenon that has been observed in physical systems like magnets, water, and piles of sand. Many systems that are composed of large numbers of interacting, similar units can reach the critical point. At that point, they behave in some very unusual ways. A similar dynamic seems at work in the brain. Some people, including myself, suspect that cortical networks within the brain may be operating near the critical point."

Beggs et al. explain that, at the critical point, the disordering force is counterbalanced by an ordering force and vice versa. At that point, the system lacks global order and consists of ordered and disordered clusters of all sizes. This is best described by a power-law distribution. At the critical point between the ordered and disordered phases, "you have the phase transition region, which is very narrow and occurs at the critical temperature." "Only at the critical temperature (*IP: at the critical point*) can you have communication that spans large distances. So if I (*IP: Beggs et al.*) were to make an analogy with a neural network, it would be that at the critical point, the neurons can communicate most strongly and over the largest number of synapses."

Beggs et al. further explain, "At the critical point two qualities of the system – coupling and variability – are balanced to produce long distance communication. And it turns out that it is not just communication that would be optimized at the critical point." Referring to other research, Beggs et al. explained that a number of brain functions seem to be optimized at the critical point, including information storage, computational power, dynamic range, and phase synchrony." The point now is not to discuss criticality of the brain as such, but rather the phenomenon that the brain's information processing functions are optimized at the critical point according to Beggs et al.

Critical point

According to Sornette (63) "in physics, critical points are widely considered to be one of the most interesting properties of complex systems. A system goes critical when local influences propagate over long distances and the average state of the system becomes exquisitely sensitive to a small perturbation; that is, different parts of the system become highly correlated. Another characteristic is that critical systems are self-similar across scales."

"A critical point is used to describe the presence of a very narrow transition domain separating two well-defined phases, which are characterized by distinct macroscopic properties that are ultimately linked to changes in the nature of microscopic interactions among the basic units. The lack of a boundary beyond the critical point makes possible a continuous movement from one phase to the other, provided that we follow the appropriate path; the critical curve (boundary) does not have to be crossed."

The critical point describes a condition where there is in fact no longer a distinction between two phases. Such a condition is reached when the control parameters of the system (in the case of water, temperature and pressure) have specific values. "The presence of this point has a crucial relevance in understanding the nature and dynamics of many natural and social phenomena" (61).

Critical slowing down

Critical slowing down is defined as a sharply marked increase in the relaxation time of a system close to a phase transition, and is by some scientists considered a dynamical signature of criticality, that can be used as a warning signal of a critical transition, and an indicator of future changes (14), (21), (37), (53), (54), (55). Relaxation time refers to the rate at which a system recovers from small perturbations.

This study shows that critical slowing down cannot be observed close to the (dual) phase transition the System experienced through the fourth systemic war (the Second World War, 1939-1945). To the contrary: during the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), there was 'critical acceleration', a phenomenon that can be attributed to the accelerating amounts of free energy (tensions) the System produced, and the need to implement upgraded orders at an accelerating pace to ensure consistency with the second law of thermodynamics.

During relatively stable periods of successive cycles, the robustness of the System increased linearly; the increasing robustness of the System increased the System's ability to 'absorb' perturbations, without producing non-systemic release events (non-systemic wars).

Critical transition

I consider critical transitions and phase transitions identical phenomena.

Crystallization point

I make a distinction between a deterministic and contingent domain in the System, that are connected through an 'interface'. Tensions are the equivalent of free energy and manifest themselves in the contingent domain of the System. Tensions, issues and states are closely related in the System, and form networks (of vulnerable clusters).

Issues between states function as 'attractors' of tensions. I assume that issues and tensions form 'crystallization points'; and that issues and tensions crystallize in fractal configurations.

Cycle

See: *Oscillation*.

Decision-making

Wars require extensive preparation and organization, and are the outcome of deliberate decision-making processes by states.

Despite differences between these decision-making processes of states, all war decisions are identical in structure: war decisions qualify as binary decisions with externalities and thresholds.

At the heart of the war dynamics of the System lies a network consisting of binary switches of war decisions by states that is linked to the network of vulnerable issue clusters in the System. Properties of this network (like its connectivity and thresholds states apply to their decisions) determine the war dynamics (their size and frequency) of the anarchistic System.
See also: *Binary decisions with externalities and thresholds, Decision threshold*.

Decision threshold

Decision thresholds can be represented by fractions. A decision fraction is defined as the ratio of the number of states that switch to a positive war decision regarding a particular issue, to the total number of states that are linked to the issue. If the decision threshold fraction is exceeded, states switch to a positive war decision.
See also: *Binary decisions with externalities and threshold, Decision-making.*

Dedicated (non-anarchistic) hierarchy

A dedicated hierarchy is a 'cluster' - level of organization - that has control over its constituents; dedicated hierarchies are non-anarchistic in nature; the security dilemma is neutralized within dedicated hierarchies.

The two clusters that were through a phase transition (1939-1945, the fourth systemic war, the Second World War) implemented in the core of the System (Europe), I refer in this study to as dedicated non-anarchistic hierarchies. Initially two dedicated hierarchies were formed: A Western and an Eastern hierarchy controlled by respectively the United States and the Soviet-Union. At a later stage – 1989 – the Eastern hierarchy collapsed and components of this hierarchy (Eastern European states) were absorbed – integrated in – the Western hierarchy, that than further evolved in what eventually became the European Union.

States also qualify as dedicated hierarchies. See also: Mattick (41).

Delay (in the development and unfolding of finite-time singularity dynamics)

During the second relatively stable period (1648-1792) the non-systemic war dynamics of the anarchistic System were temporarily – during the first exceptional period (1657-1763) – distorted. I argue that the non-chaotic non-systemic war dynamics during the first exceptional period caused a delay and energy-inefficiencies in the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles. As a consequence of the abnormal war dynamics the anarchistic System's optimum order and dynamics were temporarily distorted.

Destructive energy
Interactions between states in anarchistic systems unavoidably create issues and tensions. This is a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems. Some of these issues and tensions – further reinforced by the security dilemma and interacting self-fulfilling prophesies in anarchistic systems – are 'transformed' by states into destructive energy. With 'destructive energy' I refer to armed forces of states and their destructive capabilities (weapons, etc.). Destructive energy can be 'passively' deployed (as a threat or precaution) without actually being put to work, or actively during war (causing destruction).

Issues, tensions, and passive destructive energy deployments can be considered 'potential energy' of the System.

Deterministic, deterministic system, deterministic domain
In the System I make a distinction between a contingent and deterministic domain, that are connected through an 'interface'. This is above all an analytical distinction, to be better able to identify and describe the dynamics of the System; both domains and the interface are integrated and complement each other.

The deterministic domain concerns deterministic laws and properties, etc. Singularity-dynamics and their properties are part of – produced in – the deterministic domain of the System.

Although the deterministic domain imposes deterministic constraints, the deterministic domain also leaves some latitude for contingency ('contingent latitude'): "deterministic constraints + contingent latitude = contingent dynamics".

The deterministic domain for example, 'determines' the timing and duration of systemic wars and the amount of free energy that is put to work. The social issues these systemic wars are fought for, the 'casts' of these wars, and the 'details' of organizational arrangements that will underpin upgraded orders, etc. can be 'chosen' within the contingent domain, assuming that these 'contingent' arrangements do not conflict with the requirements of the deterministic domain.

There is interaction between both domains, at two levels: (1) at the 'daily' level through the security dilemma and interacting self-fulfilling prophecies (the mechanisms that constitute the interface), but also (2) at a more fundamental level: the intensity of (contingent) rivalries between Great Powers in the contingent domain of the System determine the number of degrees of freedom in the System; the number of degrees of freedom in the System determine the nature – chaotic or non-chaotic – of non-systemic wars in the System.

Differentiated growth (paths and speeds)
With the term 'differentiated growth' I refer to the phenomenon that states develop – at least to a certain extent – in different ways, in different directions, and with different speeds (see also: (26)).

Differentiated growth impacts on the status of states, and their rivalries. Differentiated growth contributes to the phenomenon that certain Great Powers still enjoy certain privileges that are embedded in the (current) international order of the System, while more recent developments can in fact no longer justify those privileges; these states lost their ability to leverage the powerful-become-more-powerful effect.

However, the reverse is also the case: certain states at a certain point qualify as Great Power, but their 'new' status is not (yet) reflected in the international order that is in place. Differentiated growth contributes to Great Power status dynamics, rivalries, and the production of free energy (tensions) in the System.

Dimensions of the first finite-time singularity dynamic (1495-1945)
It is possible to distinguish between two dimensions – 'lines' of development – of the finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period: (1) increasing integration of units/states in the core of the System (Europe), and (2) simultaneous expansion of units/states to non-core territories of the System. These are related developments that ultimately – when in 1939 the System reached the critical connectivity threshold (the singularity in finite time) – resulted in a dual phase transition. Through the dual phase transition the System simultaneously implemented two dedicated non-anarchistic hierarchies in the core of the System (Europe), and a first global order at a global level of the System, to ensure compliance of the System with the demands of the second law of thermodynamics.

Domain (related to basic requirements)
In order to survive humans and social systems (including states) have to perform certain functions and tasks that ensure the fulfillment of their basic requirements. Each basic requirement is related to a certain domain: 'Security' to the '(International) System, 'Welfare' to the economic domain, 'Identity' is related to culture and religion, and 'Integration' is related to 'balance' and the political system of states (that is supposed to achieve 'balance' in states). Domains 'overlap' and the 'total' system has holistic properties.

Domains and basic requirements 'interact': Security impacts on economic activities (welfare); the level of welfare defines what are considered security risks; identity defines political systems, etc.

For a social system to be 'in balance' the domains – and the underlying principles that govern/regulate these domains – must be consistent. It is the function of the integrative system to maintain this balance, internal as well as with the constantly evolving environment. Connectivity growth – resulting in increasing economic interdependence, but also in an increasing tension levels – 'pushes' for integration.

Individuals and populations are embedded in various 'organizations' (including states) to ensure the fulfillment of their basic requirements. States are responsible for the security (internal and external) of their populations. Individuals and groups within states develop economic activities, and have and further develop identities. Maintaining a certain balance (internally as well as externally), when the connectivity at all levels of organization continuously grows, can become problematic.

Individuals and groups (including states) are 'confronted' with other individuals and groups that follow different and sometimes incompatible aims and 'logics'. This has an impact on the balance – consistency – individuals and groups need to achieve. When religions prescribe 'social/behavioral laws' that 'conflict' with social laws that are prescribed by integrative (political) systems, or the other way around, imbalances result; one way or the other these imbalances must be resolved.

Each domain must achieve some basic requirements to ensure the survival of the individual and the group. These basic requirements are not always explicit. However, in case of security of states, some 'hard' requirements are generally accepted, and embedded in international laws to avoid tensions and conflicts: states for example must respect the territorial integrity and sovereignty of other states.

States can be seen as 'organizations' that try to fulfill and balance – through their integrative system – the basic requirements (needs) of their populations. However, not only do states have basic requirements and domains that states must integrate/balance; domains 'as such' also develop their own 'logic', structures, and dynamics.

The singularity-dynamic of the European System can be seen as the outcome of efforts of states (in the contingent domain) to control their security requirements. The shifting/changing requirements of states, the integrative efforts of states, and the autonomous 'emerging' dynamics of and in domains form a dynamic system.

Domains develop their own 'self-organized' dynamic that is the outcome of the 'micro' interactions of their components. The singularity dynamic is a striking example. From this perspective systemic wars can be defined as a collective 'security crisis', the collective inability – as a consequence of the emerging macro dynamics of the System – for states to fulfill this particular basic requirement.

The economic domain, also develops emergent macro dynamics, as a result of the micro-dynamics of its components (states, businesses, etc.); Kondratieff- and business cycles are manifestations of periodic imbalances and efforts to re-establish stability that are produced in the economic domain.

Whereas the System rebalances – corrects – itself through systemic wars, the economic domain produces recessions and 'depressions' causing the destruction – bankruptcies – of businesses and vice versa (creative destruction) and the introduction of new economic policies. As discussed in part III, the cycles of the first finite-time singularity dynamic (1495-1945) and Kondratieff-cycles the System produced were not synchronized.

The finite-time singularity dynamic accompanied by four accelerating cycles that unfolded during the 1495-1945 period, resulted in the implementation of (initially) two dedicated non-anarchistic hierarchies in the core of the System (Europe), that later (in 1989) merged into one. Obviously, integration and economies of scale and scope, have much to offer: more security, more welfare, etc. However, the integrative (political) system must ensure a certain balance between the domains of the enlarged hierarchy.

Identity development must be an integral part of the new balance. Cultural and religious must also be integrated and balanced with other domains.

Domino effect

Cascades – war cascades – the System produces can be understood as domino effects. Cascades – the domino effect – are 'cumulative' effects when a decision of one state to 'go to war' sets off a chain of similar decisions by other states. War cascades – domino effects – in the System are 'regulated' by the connectivity of the issue-network.
See also: *Cascade(s)*.

Doubly periodic non-systemic war dynamics

During the first exceptional period (1657-1763), the System produced doubly periodic non-systemic war dynamics; the war dynamics repeated themselves in two 'dimensions', it is possible to identify two periods.
See also: *Periodic window*.

Dual-phase transition

When in 1939 the anarchistic System reached the critical connectivity threshold (the singularity in finite, time, the anarchistic end state) and produced 'infinite' amounts of free energy (tensions) as a consequence of the intrinsic incompatibility of connectivity and security in anarchistic Systems, the anarchistic System collapsed. In response – to ensure consistency with the second law of thermodynamics – the System produced a dual phase transition. To ensure consistency with the second law of thermodynamics, through the fourth systemic war (the Second World War, 1939-1945), two dedicated non-anarchistic hierarchies, and a first global order at a global scale of the System, were simultaneously implemented.

Dynamics of and on the network (System)

A distinction can be made, at least analytically, between the dynamics *of* the 'underlying' network of vulnerable issue clusters and the dynamics *on* this network (e.g., wars). This distinction is related to the distinction between an underlying deterministic domain and a contingent domain. Whereas the dynamics *of* this underlying network show remarkable regularities, the events that unfold on this network are, at least in some aspects, contingent.

Historians and social scientists typically focus on the dynamics *on* the network of states and issues, as well as on events that occur in the contingent domain of the System. Dynamics *of* the underlying network (the deterministic domain) determine and shape contingent events.

Early Warning Signal(s) (EWS)
With the term 'early warning signals' I refer to signals in the dynamics and (development of) properties of the System that indicate the System is about to become critical and produce a systemic war, or is reaching the critical connectivity threshold, implying the System's collapse and a phase transition.

This study shows that certain regularities in the dynamics of the System and in the development of its properties, in combination with the 'critical fraction' of non-systemic wars, provide powerful early warning signals, see Part IV.

Eastern hierarchy
See: *Dedicated hierarchy*.

Edge of chaos
The 'edge of chaos' concerns a concept introduced by Kauffman (36). The edge of chaos correspondents with a system's critical point. Kauffman argues that the edge of chaos (a critical point) is the attractor of certain complex systems, because their performance and evolvability are than optimized. The concept of the edge of chaos is to a high degree identical with 'self-organized criticality' (5).

Emergence.
The phenomenon of 'emergence' is related to self-organization and refers to structures and regularities that arise in the System and its dynamics as a consequence of the interactions between states and their populations
See also: *Self-organization*.

Empowerment
Empowerment of individuals and communities refers to the ability of individuals and communities to organize themselves; for example, in network structures that allow individuals and communities to integrate their interactions and activities through shared values and norms. Such networks are able to adjust to local conditions and events and leverage 'local' economies of scale and scope (synergies). Networks can strike an optimal balance between shared requirements and local initiatives. Empowerment is enabled through the Internet, social media, communication technology, and global mobility.

Enabled properties

With the term 'enabled properties', I refer to the fact that the properties of the System and its dynamics depend on certain conditions of the System. When – for example – the number of degrees of freedom (n) of the System is two (n = 2) the System cannot produce chaotic non-systemic war dynamics, become critical and implement upgraded orders through systemic wars.

Another example concerns the properties of the System during criticality. Criticality implies (by definition) that the system in question has a correlation length of 'one' that spans the system. Because of this property, criticality enables system-wide communication, coordination and planning; these are prerequisites for the System – states in the System – to collectively design and implement viable (upgraded) orders, that (more or less) meet the requirements of all states in the System (at least temporarily); system-wide communication, coordination and planning are enabled properties during criticality.

Energy

Energy in the System is subject to various physical laws, including the second law of thermodynamics. Concerning the production, use and purpose of free energy, the following related deterministic properties are relevant:

1) *Production*. The production of free energy (tensions) is a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems.
2) *Use*. Release of free energy follows the path of least resistance.
3) *Purpose*. Through systemic wars free energy will be put to use ('to work') to implement upgraded orders that allow for a lower energy states of the System.

See also: *Tension*.

Energy inefficiencies

With the term 'energy inefficiencies' I refer to the significant higher amounts of free energy (tensions) that were produced during the first and second exceptional periods (respectively 1657-1763 and 1953-1989), and to significant higher amounts of destructive energy that were deployed during the first exceptional period (during the second exceptional period, non-systemic war dynamics were not more extreme, but more subdued).

I argue that the abnormal – more extreme – non-chaotic non-systemic war dynamics during the first exceptional period, distorted the otherwise optimal dynamics of the anarchistic System. This analysis shows that about 31 percent more destructive energy was deployed during the second cycle (1648-1815) than would have been the case if the non-systemic wars were not temporarily distorted. This effect – an over-production of free energy (tensions) and 'over-deployment' of destructive energy – I refer to as 'energy inefficiencies'.

At this stage of development of the second finite-time singularity dynamic

(1945-...), it is not possible to determine if the abnormal war dynamics during the second exceptional period (1953-1989) caused any energy-inefficiencies.

Energy release

Energy releases and wars in the System are equivalent; energy releases concern the deterministic domain; wars the contingent domain of the anarchistic System. Energy releases obey physical laws. As a consequence of the intrinsic incompatibility between connectivity and security in anarchistic systems, the System produces free energy, tensions.

At certain points/moments the System releases free energy through non-systemic and systemic wars; the equivalent of these (deterministic) energy releases, are non-systemic and systemic wars in the contingent domain of the System. Deterministic laws determine, when and where, energy is released, including the duration of these release events, and the amount of energy that is released.

The Law of Thermodynamics applies to the free energy in the System, and the law's application – in combination with a number of other deterministic laws, principles and mechanisms – resulted in a finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), each cycle consisting of a relatively stable period ('international order'), followed by a systemic war.

Typically, during high-connectivity regimes of relatively stable periods, the ability of the System to release energy (tensions) through non-systemic wars increasingly diminishes, while at the same time, the production of free energy (tensions) further accelerates. Instead of being released, the free energy – unresolved issues and tensions – are 'stored' in the System, form a 'free energy release deficit' and crystallize in vulnerable issue clusters with fractal structures that eventually percolate the anarchistic System, cause it to become critical, and produce systemic wars. Consistent with the 'demands' of the second law of thermodynamics, through systemic wars, free energy (tensions) is put to work, to implement upgraded orders to allow for lower energy states of the System. Lower energy states are a prerequisite for stable periods (international orders), that allow for further growth and development.

This above all, is a description of the System and its dynamics from the perspective of the deterministic domain. Although the deterministic domain determines the dynamics and development of the System, some 'latitude' is left for contingent dynamics (the contingent domain); in principle 'all' contingent dynamics are possible ('allowed') as long as they do not conflict with – infringe on – deterministic laws. Free energy produced in the deterministic domain, result in contingent issues and tensions (and contingent dynamics), within the 'contingent-latitude' allowed by the deterministic domain. It can be said that: "deterministic restrictions + contingent latitude = contingent dynamics".

The configuration of the System (also) determines when and where free energy is produced and released; over time – during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) – the size-distribution of states could be best described by a power-law, pointing to their (increasingly) fractal structures. These fractal structures ensured that tension-production in the System was minimized (during relatively stable periods), and the distribution of destructive energy during systemic wars was optimized.

Energy release distribution (during cycles)
During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the energy release distribution during successive cycles shifted in favor of systemic wars. I define the ratio of the severity of the systemic war of a cycle and the total severity of all wars during the cycle, as the release ratio of a cycle. I consider the severities of wars indicative for the amounts of free energy that is released, and for the destructive energy that is deployed during wars.

The change in the energy release distribution can be attributed to the increasing robustness of successive relatively stable periods of cycles. Ultimately, when during the fourth relatively stable period (1918-1939), the anarchistic System became completely robust, the release ratio became one, meaning that all energy was (and only could be) released during the fourth systemic war (the Second World War, 1939-1945).

The development of the release ratio shows a significant distortion during the second cycle (1648-1815), as a consequence of the abnormal non-systemic war dynamics during the first exceptional period (1495-1945).

Energy state (of the System)
Energy state refers to the amount of free energy – tensions – in the System. The second law of thermodynamics determines what levels of order of the System accompany certain energy states in the System. If the level of free energy (tension) in the System and its order are not consistent, the second law of thermodynamics will put free energy to work to upgrade the order of the System to allow for a lower energy state.

The ability of the System to stay for an 'extended' time in an order (configuration) other than the System's state of least energy, determines the System's metastability.
See also: *Lower energy state* and *Metastability*.

Equilibrium
In case of equilibrium of the System, competing forces – order and disorder – are to a certain degree balanced, allowing the System to fulfill its function(s). The performance and evolvability of the System are measures for the System's functionality. During relatively stable periods the anarchistic System is 'balanced'; during systemic wars the System implements upgraded orders that (again) allow for lower energy states of the System, given its greater connectivity and higher free energy production of the System.

During the 1495-1945 period, balancing at system-level was accomplished through the first finite-time singularity-dynamic which was accompanied by four accelerating cycles.

During relatively stable periods, the System maintains a certain balance through non-systemic energy releases (non-systemic wars).

Given the continuous input of free energy, maintaining balance (at multiple levels of the System) is a continuous challenge.

Given the intrinsic incompatibility between connectivity and security in anarchistic systems, and the accelerating production of free energy this results in, anarchistic systems are unstable. The core of the anarchistic System collapsed in 1939, and this study suggests – assuming that population growth of the System continuous – that the anarchistic System will again collapse at a global scale around 2185.

European System

During the 1495-1945 period, the dynamics and development of the System were to a (very) high degree dominated by a finite-time singularity dynamic accompanied by four accelerating cycles. Europe constituted the core of the System. The finite-time singularity dynamic was instrumental in the simultaneous integration of the core, and expansion to non-core territories of European states. Because Europe to a high degree dominated the dynamics of the System (at least initially), during the period 1495-1939, the anarchistic System could be designated as the 'European System'. The phase transition (1939-1945) marks the actual globalization of the System.

Evolvability

Evolvability refers to the System's ability to timely adapt to the increased connectivity of the System and higher levels of free energy (tensions) this implies, by implementing upgraded orders through systemic wars. Evolvability of the System is closely related to its *performance*.

By periodically adjusting its organization – by implementing upgraded orders – the System ensured (and still ensures) its performance and viability. The System – through international orders – ensures that uneven states (states that differ in power, influence and interests) can fulfill their basic requirements in an anarchistic system by providing certain arrangements that balance (at least temporarily) conflicting interests.

Exceptional period(s)

The System experienced two exceptional periods: the first exceptional period (1657-1763) during the life span of the second international order (1648-1792), and a second exceptional period from 1953-1989, better known as the Cold War, during the life span of the first global order (1945-...).

During both exceptional periods the System produced 'abnormal' war dynamics that impacted on the development of the System. During the first exceptional period the System produced periodic instead of chaotic non-sys-

temic war dynamics; during the second exceptional period the war dynamics of the System were highly subdued. In both cases the abnormal – non-chaotic non-systemic war dynamics – were produced by intense rivalries between certain Great Powers in the System, respectively between Britain and France during the first exceptional period, and between the United States and the Soviet Union (and the respective hierarchies they controlled) during the second exceptional period.
See also: *Abnormal (non-chaotic) non-systemic war dynamics.*

Expansion
Expansion is an integral component of the process of social integration and expansion in the System. During the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), states in the core of the anarchistic System (Europe) integrated, while at the same time these states expanded their control (and exploitation) to non-core territories. Both process interacted and to an extent reinforced each other.

It was only a matter of time before non-core territories (that were increasingly modeled as states) developed their 'own' autonomous dynamics and rivalries.

Exponential growth
See: *Modes of behavior of dynamical systems.*

Expansion wars
During the 1495-1945 period the anarchistic System produced a finite-time singularity dynamic accompanied by four accelerating cycles. Through the finite-time singularity dynamic the System balanced order and disorder and ensured the performance and evolvability of the anarchistic System. The finite-time singularity dynamic and population growth was a self-reinforcing dynamic.

The finite-time singularity dynamic was also instrumental in a simultaneous process of integration in the core of the System (Europe), and expansion to non-core territories by European states. This also constituted a self-reinforcing process.

During the lifespan of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the anarchistic System produced four accelerating cycles; each cycle consisting of a relatively stable period (international order) followed by a systemic war.

During the four relatively stable periods the anarchistic System produced respectively 45 - 34 - 21 - 6 (total: 106, expansion wars included) non-systemic wars. A closer look, however, reveals that nine of these wars, concern the expansion of the core of the System to non-core territories, and autonomous non-core war dynamics (states in the non-core) produced.

These 'expansion wars', as I name them, are in a number of cases excluded from analysis of the dynamics of the core of the System.

In below table I specify these wars.

Expansion wars (Data based on Levy (38))				
	Number Levy	Name	Period	Great Power involvement
1	88	War of 1812	1812-1814	England
2	97	Anglo-Persian War	1856-1857	England
3	99	Franco-Mexican War	1862-1867	France
4	104	Sino-French War	1884-1885	Fra+++nce
5	105	Russo-Japanese War	1904-1905	Russia
6	109	Manchurian War	1931-1933	Japan
7	110	Italo-Ethiopian War	1935-1936	Italy
8	111	Sino-Japanese War	1937-1941	Japan
9	112	Russo-Japanese War	1939-1939	Russia, Japan

Table 126 *Expansion wars during the first finite-time singularity dynamic, 1495-1945.*

Although the 'War of the American Revolution' (war number 81 (1778-1784) in Levy's dataset (38)) took place outside the core of the System (outside Europe), I do not consider this war an 'expansion war', but foremost an European War that was fought outside the core of the System. Contrary to the nine expansion wars (mentioned in above table), three Great Powers were involved in the 'War of the American Revolution': France, England and Spain.

Feedback (process)

Because "the feedback structure of a system generates its behavior", "much of the art of systems modeling is discovering and representing the feedback processes, which, along with stock and flow structures, and with time-delays, and nonlinearities, determine the dynamics of a system", Sterman (69) argues. Real systems, like the System, are nonlinear, meaning that the feedback loops and parameters governing the dynamics vary depending on the state of the system.

Most complex behaviors arise from the interactions (feedback) between components of the system, not from the complexity of the components themselves. Dynamics arise from the interaction of just two types of feedback loops, positive (or self-reinforcing) and negative (or self-correcting). Loops can be illustrated using 'causal loop diagrams' (CLDs), which are maps that show causal links among variables with arrows from a cause to an effect. Correlations are not included in these diagrams: "Correlations among variables reflect the past behavior of a system. Correlations do not represent the structure of the system." Correlations among variables will emerge from the behavior and dynamics of the system.

Positive loops tend to reinforce or amplify whatever is happening in the system. This is also the case in the System as population and connectivity growth, for example, produce tensions that then result in the buildup of destructive energy and alliance dynamics. A security dilemma is inseparably linked to anarchistic systems and constitutes a self-reinforcing (positive feedback) loop. As a consequence of the security dilemma, the buildup of destructive energy and alliance dynamics, which were initiated in response to rising tensions, create more tensions and stimulate further buildup of destructive energy and alliance dynamics. “Most dynamics observed in the real world are examples of a small set of basic patterns or modes of behavior. Three of these modes are fundamental: exponential growth, goal seeking, and oscillation. Each of these modes is generated by a particular underlying feedback structure. Positive feedback processes generate exponential growth. However, goal seeking is generated by negative feedback, and oscillations are generated by negative feedback with delays. More complex patterns of behavior, such as S-shaped growth, growth with overshoot, and overshoot and collapse, result from the nonlinear interaction of these basic feedback structures.”

Negative loops counteract and oppose change. While tensions and destructive energy produce disorder in the System, other forces will counteract this change and try to re-establish certain order.

All systems, no matter how complex, consist of networks of positive and negative feedback loops, and, as already mentioned, all dynamics arise from the interaction of these loops with one another. When multiple loops interact, it can be difficult to determine what the dynamics will be. System dynamics emphasizes the multi-loop, multistate, nonlinear character of the feedback systems, as well as the multiple connections in which we live. The System meets all these system dynamics conditions.

Sterman observes, “adding time delays to negative feedback loops increases the tendency for the system to oscillate.” Delays create instability in dynamic systems.

The cycles that accompanied the finite-time singularity dynamic of the System that unfolded during the period between 1495–1945 are a consequence of a delayed response of the System to counter increasing disorder. This study shows that, when the System eventually reaches a critical point, a systemic war will be triggered to counter the ‘disorder’ (the unresolved tensions and issues) that has accumulated in the system. A systemic war is an ordering force and, through systemic wars, new increasingly upgraded orders were introduced in the System.

Finite-size effects

Finite-size effects are associated with finite-time singularities. Finite-time singularities are ‘produced’ by systems that experience accelerating growth rates. Such growth rates are (as a matter of time) unsustainable.

Driven by continuously growing populations and connectivity, the four cycles that accompanied the singularity dynamic during the 1495-1945 period, accelerated at an increasing rate; the same is true for the destructive energy that had to be deployed through successive systemic wars to design and implement upgraded orders (to meet the requirements of the second law of thermodynamics). These growth requirements, however, could at a certain point not be met: Destructive energy could (and cannot) be produced in infinite amounts and at infinite rates, and can also not deployed without destroying the System itself. These 'practical' limitations and their effects on the unfolding of the finite-time singularity dynamic are referred to as finite-size effects. Finite-size effects explain why the System did not (and was unable) to produce a fifth systemic war (a 'Third World War') before ultimately collapsing and experiencing a (unavoidable) phase transition: collapse (1939) and a phase transition (1939-1945) occurred somewhat earlier than the theoretical model of the finite-time singularity dynamic predicts.

Finite-time singularity dynamic

The finite-time singularity accompanied by four accelerating cycles the anarchistic System produced during the 1495-1945 period, is a manifestation of the competition between order and disorder in the System.

The singularity dynamic was powered by the free energy (tensions) that was produced as a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems. The finite-time singularity dynamic started around 1495, when (a (still) diverse and large) number of units in Europe became sufficiently connected to develop system-behavior. Consistent with the second law of thermodynamics, the free energy the anarchistic System produced was periodically put to work – through four systemic wars – to implement upgraded orders that allowed for lower energy states of the System. Because of the accelerating amounts of tensions that were still produced in the System, as a consequence of the intrinsic incompatibility between connectivity and security, the upgraded orders were only temporarily viable: The intrinsic incompatibility between connectivity and security was not resolved by the orders that were implemented in the anarchistic System. The accelerating growth rate of tensions (free energy) was however unsustainable.

In 1939, when the System reached the critical connectivity threshold – the singularity in finite time – the anarchistic System produced infinite amounts of free energy (tensions). As a consequence, the anarchistic System collapsed and produced a phase transition. The fourth systemic war (the Second World War, 1939-1945) constituted the phase transition and resulted in the implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe), and the simultaneous implementation of the first global order at a global scale of the System.

The finite-time singularity can be depicted as a competition between two 'forces'; between order (implying a low level of free energy) and disorder (implying a high and increasing level of free energy, eventually forcing the

System to implement upgraded orders to ensure compliance with the second law of thermodynamics). In the deterministic domain the second law of thermodynamics applies to these forces, which in fact constitute energy.

In the contingent domain these forces also manifest themselves as order – forces that provide and maintain structural stability, for example by actively maintaining the status quo and resisting change – and disorder; manifested by issues and tensions in the System, that hamper (inter)actions between states to fulfill their basic requirements, necessary for their survival.

Deterministic dynamics that obey physical laws, determine the latitude for contingent dynamics of the System, which cannot contradict these laws.

In the contingent domain, successive upgraded orders that were implemented through systemic wars (during periods of criticality of the anarchistic System) constitute(d) a process of social integration and expansion.

Fitness

Evolution is directed towards higher fitness: reproductive success and improved survival changes. Selection and self-organization are mechanisms that shape evolution and evolvability. Evolution in social systems is directed towards social integration and expansion (SIE). SIE makes it possible to exploit synergies: economies of scale and scope that contribute to the fulfillment of basic requirements, and survival of social systems.

Flickering

The phenomenon, when a system because of an unstable control temporarily falls back into a previous stability domain, is also referred to as 'flickering' (53), (21). The question is if 'Europe' - now organized in a single non-anarchistic hierarchy through the 'European Union' - will develop a flickering dynamic, and (temporarily) disintegrate - fall back- in fully autonomous state-structures. 'Brexit' (Britain exiting the European Union) could be indicative for such a development.

Fractals and Fractality

Fractals are self-similar structures. With '*fractality*' I refer the degree in which structures are fractal in nature. Structures are self-similar – fractal – if they contain replicas of themselves in many different sizes. In other words, they have similar structures at all scales. Contrary to mathematical fractals, real fractals have some cut-off sizes above and below which self-similar structures fail to appear.

Fractals are ubiquitous in nature and in social processes and structures. It is not exactly clear why and how fractals are formed. I assume (see also Jensen (32)) that the principle of least free energy selects for these typical structures and that fractal structures point to optimality. As is (often) the case in other systems, I argue that fractal structures are best able to reconcile conflicting requirements and optimize certain properties in a system (network) of nodes that regularly interact. Bettencourt et al. (11) observe in relation to fractal structures: "Highly complex, self-sustaining structures, whether cells, organisms, cities require close integration of enormous numbers of constituent units that need efficient servicing".

"To accomplish this integration", Bettencourt et al. continue, "life at all scales is sustained by optimized, in some cases space filling, hierarchical branching networks which grow with the size of the organism as uniquely specified approximately self-similar structures… Because these networks, e.g. the vascular systems of animals and plants, determine the rates at which energy is delivered to functional units (cells), they set the pace of physiological processes as scaling functions of the size of the organism." It is the "self-similar nature of resource distribution networks, common to all organisms, that provides the basis for a quantitative, predictive theory of biological structure and dynamics, despite much external variation in appearance and form."

Bettencourt et al. relate these observations not only to biological, but also to social systems: "From this perspective, it is natural to ask whether social organizations also display universal power law scaling for variables reflecting key structural and dynamical characteristics." This line of thought is at the basis of Bettencourt's et al. study of "*Growth, innovation, scaling, and the pace of life in cities*" (11).

West et al. (75) point to the relationship between selection and optimization: "Natural selection has tended to maximize both metabolic capacity, by maximizing the scaling of exchange surface areas, and internal efficiency, by minimizing the scaling of transport distances and times."

As mentioned in this study, a system at a critical point has fractal structures. A power-law distribution implies fractal structures. Although criticality and phase transitions are accompanied by fractal structures, fractals structures (power laws) can also be produced by other mechanisms. Criticality is in other words not a prerequisite for 'fractality'.

The power-law that best describes the size distribution of wars is not indicative of criticality of the System. This particular power law is produced by the chaotic and periodic properties of war dynamics.

In this study, I also discuss and explain why military organizations developed fractal organizational structures during the unfolding of the finite-time singularity dynamic (1495-1945); these structures are not a coincidence or a twist of nature. The fractal structure of military organizations, along with their fractal capabilities at various levels of organization, have evolved over time in response to the structure of military activities and vice versa. These fractal structures are the outcome of a collaborative optimization process.

I explained that systemic wars are indicative of the criticality of the System. I assume that systemic wars therefore have fractal structures, and that the size distribution of the 'components' of systemic wars (campaigns, battles, fire fights, etc.) can best be described with a power law. A closer look at the size distribution of states shows that this distribution can also best be described with a power law, also implying fractality. I argue that this fractality is also not a coincidence: the fractal structures of the System – the fact that the size distribution of states can be best described by a power law – is a consequence of the fractal structures of the activities that constitute systemic wars, and fractal organizations that fight these wars.

In previous parts, I explained that the fractal nature of systemic war activities, and of the fractal System they produced (and vice versa), point to their highly optimized condition; both are produced by the finite-time singularity during the period 1495–1945, itself also a highly optimized process, as I will explain later.

Bak (5) explains the dynamical origin of fractals (not surprisingly) as the outcome of a self-organized critical process: "Thus, Vicsek's group had demonstrated in a real experiment that fractals can be generated by a self-organized critical process, precisely as predicted from the sandpile simulations and as found also by the Norwegian group. Mandelbrot, who coined the term fractal, rarely addressed the all-important question of the dynamical origin of fractals in nature, but restricted himself to the geometrical characterization of fractal phenomena. The Hungarian experiment showed directly that fractals can emerge as the result of intermittent punctuations, or avalanches, carving out features of all length scales. Thus it is a very tempting suggestion that fractals can be viewed as snapshots of SOC dynamical processes! In real life, where time scales are much longer than in the laboratory, landscapes may appear static, so it may not be clear that we are dealing with an evolving dynamical process. In the past, geophysicists have fallen into this trap when dealing, for instance, with earthquakes as a phenomenon occurring in a preexisting fault structure. The chicken (geometric fractal structure of the network of faults, or the morphology of landscapes) and the egg (earthquakes, landslides) were treated as two entirely different phenomena." Bak in other words also observed a relationship/interaction between fractal processes and fractal structures.

Bak also addressed the dynamic origin of fractals by suggesting that SOC is the mechanism that produces these structures. I assume that fractal structures enable optimized distribution of resources, information but also of (destructive) energy in the System. Fractal structures and processes are closely related phenomena.

Fractal structures and optimization

Fractal structures and processes ensure the simultaneous maximization of the scaling of exchange surface areas, and minimization of the scaling of transport distances and times. Fractal structures are optimal structures.

Fractal structures and processes can also be observed in the System; in all cases these structures are responsible for – concerned with – distribution. For example, the deployment of destructive energy during systemic wars can also be considered a distribution process that can, in principle, be optimized following the same logic and trade-offs as other processes of life.

Systemic wars (i.e., optimized distribution of free energy during criticality), state structures (i.e., minimal production of free energy, optimal distribution to rebalance), military organizations (i.e., optimal distribution of destructive energy), and casualty dynamics (i.e., fractal effects carved out by fractal war activities) all have fractal structures that point to their optimization; these fractals are 'products' of the second law of thermodynamics. These fractal structures are related.

Fragility

Fragility is a property of the anarchistic System that determines how long the System can sustain itself within a certain (international) order, before becoming critical and being forced (by the second law of thermodynamics) to implement an upgraded order through systemic war, that again enables a (temporary) lower energy state of the System. The life span of successive relatively stable periods is a measure of the System's fragility. Robustness and fragility are closely related properties, two sides of the same coin: increased robustness and increased fragility go hand in hand in the System.
See also: *Robustness*.

Fragmentation

See: *Social fragmentation*.

Free energy

Free energy is the energy in a system that can be converted to do work. The second law of thermodynamics determines that all processes occur in order to minimize the overall free energy; systems strive to decrease free energy. Systems can reduce their free energy by introducing order. Through a transition to another – more ordered – state, the system reduces its free energy.

An example: Temperature 'controls' the phase (state) of water; temperature is its control parameter. "Suppose the temperature is, say, thirty degrees centigrade. At this temperature, the amount of thermal agitation is such that the liquid phase of water is the most stable (i.e. has the lowest free energy), compared to the other two competing phases, namely the vapor phase and the solid phase. As we cool the system, the degree of thermal agitation goes on decreasing, and at zero degrees centigrade a different phase of water (namely ice) becomes a stronger contender for existence: The system can lower its free energy by a substantial amount, by making a transition to the ice phase" (71).

Connectivity is the control parameter of the System. The 'overall' connectivity of the System, as well as the connectivity of vulnerable issue clusters during high connectivity regimes of relatively stable periods, continuously increased during the 1495-1945 period (in fact connectivity of the System still is increasing), respectively through population growth of states, and rivalries between states. As a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems, the

System produced (and still produces) tensions; tensions are equivalent with free energy, to which the second law of thermodynamics applies.

Consistent with the second law of thermodynamics tensions are periodically put to work by the System, to implement 'upgraded' orders that allow(ed) for lower free energy states of the System. Tensions are transformed into destructive energy, and put to work during critical periods; through systemic wars.

Because of the accelerating growth rate of tensions in the System, the System became critical and produced systemic wars at an accelerating during the 1495-1945 period. Ultimately, when the anarchistic System in 1939 reached the critical connectivity threshold, the incompatibility between connectivity and security in the anarchistic System had become infinite; as a consequence, the System produced infinite amounts of free energy (tensions) and collapsed.

To ensure compliance with the second law of thermodynamics, the System produced a phase transition that resulted in the implementation of two dedicated non-anarchistic hierarchies in Europe. Because anarchy was neutralized within respective hierarchies, within these hierarchies free energy was no longer produced.

Three principles concerning 'free energy' apply (also) to the System: (1) the principle that free energy will be put to work, (2) the principle that free energy is put to work to implement upgraded order(s) that allow for a lower energy state of the System, and (3) the principle of least resistance, concerning how free energy will be put to work.

Because of certain properties of the System, the free energy the System generated produced a finite-time singularity dynamic during the 1495-1945 period. The singularity dynamic was instrumental in the implementation of successive upgraded orders, and ultimately in a phase transition as just described. In the contingent domain this process – the application of free energy – resulted in a next level of social integration and expansion in respectively Europe, in the core of the System, and at a global scale.

In fact – this is a somewhat different perspective of the same phenomenon – the production of free energy (tension) by the System, as a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems, constituted a continuous influx of energy in the System, that pushed the System more and more away from equilibrium, and forced the System – through the second law of thermodynamics – to seek (again and again) new steady states (international orders), to be able to perform its function. This dynamic resulted in a process of "emergent self-organized order and pattern formation, implying a local lowering of entropy (or increase of order), and a concomitant evolution of complexity" (71).

Free energy release deficit

During high-connectivity regimes of relatively stable periods, instead of being released free energy (tension) is 'stored' in the System, and forms a 'free energy release deficit', and crystallizes in vulnerable issue clusters with fractal structures. The moment the vulnerable issue clusters percolate the System, and cause it to become critical, the System produces a systemic war. During systemic wars the free energy (tensions and unresolved issues) that is 'stored' in the System, is put to work to implement upgraded orders that allow for lower energy states of the System.

During systemic wars the System makes 'use' of its critical properties: because at critical points the System's correlation length is one, system-wide communication, coordination and planning are 'enabled'. These critical properties make it possible for states to collectively design and implement upgraded (system-wide) orders through systemic wars.

Free will

With the term 'free will' I refer to the ability of states, their populations, decision makers, etc. to choose between different courses of action. This study shows that our 'free will' (at least concerning war, war dynamics, and development of the System) is much more restricted than we assume(d.) This study shows that the dynamics and development of the System are highly deterministic in nature; the System obeys physical laws, it cannot 'ignore'.

The timing and duration of systemic wars, but also the amount of energy that is released during these wars, are deterministic properties of the System and its dynamics. Systemic wars are 'forced' (imposed) on the anarchistic System, by the second law of thermodynamics; 'free will' does not apply.

However, and that is the merit of the security dilemma and interacting self-fulfilling prophecies, we are thought to believe that we control these events: This study shows our collective ability (and preparedness) to be collectively deceived, without even noticing.

The extent to which free will can be 'applied' - the contingent latitude of the System - is determined by deterministic constraints that apply. During the unfolding of the first finite-time singularity dynamic (1495-1945), the anarchistic System increasingly resembled a war trap, that increasingly limited the contingent latitude of the System (and how it could be used): systemic wars had to be produced at an accelerating rate and with accelerating severities; there was 'no' choice, other than in 'creating' specific social issues and producing a 'cast', that would ensure the necessary production and deployment of tensions and destructive energy.

Global awareness and responsiveness

The term global awareness and responsiveness refers to (1) the ability of states to perceive – to 'construct' – an image of the System and its dynamics, that more or less accurately depicts the threats and opportunities these states confront, or will confront in the future, and (2) to act in accordance with its interest (basic requirements) to neutralize threats and leverage opportunities. How states perceive the System, is subjective, and closely related to their basic requirements.

Globalization point of the System

The globalization point of the System is the point in time – December 1941 – when the System from a security and war dynamics perspective became globally connected. Through the Japanese attack on the United States (Pearl Harbor, 7 December 1941), and the subsequent German declaration of war on the United States (on 11 December 1941), issues in Asia and the already critical core of the System (Europe, starting 1939), became connected and formed a cluster that spanned the global System. In 1941, the System became critical at a global scale, for the first time.

Goal seeking

See: *Modes of behavior of dynamical systems.*

Great Power

I quote Levy (38): "A Great Power is defined here as a state that plays a major role in international politics with respect to security-related issues. The Great Powers can be differentiated from other states by their military power, their interests, their behavior in general and interactions with other powers' perception of them, and some formal criteria."

"Most important, a Great Power possesses a high level of military capabilities relative to other states. At a minimum, it has relative self-sufficiency with respect to military security. Great Powers are basically invulnerable to military threats by non-Powers and need only fear other Great Powers. In addition, Great Powers have the capability to project military power beyond their borders to conduct offensive as well as defensive military operations. They can actively come to the defense of allies, wage an aggressive war against other states (including most of the Powers), and generally use force or the threat of force to help shape their external environment."

"Second, the interests and objectives of Great Powers are different from those of other states. They think of their interests as continental or global rather than local or regional. Their conception of security goes beyond territorial defense or even extended defense to include maintenance of a continental or global balance of power. Great Powers generally define their national interests to include systemic interests and are therefore concerned with order maintenance in the international system. Symbolic interests of national honor and prestige are also given high priority by the Great Powers, for these are perceived as being essential components of national power and necessary for Great Power status."

"Third, the Great Powers are distinguished from other states by their general behavior. They defend their interests more aggressively and with a wider range of instrumentalities, including the frequent threat or use of military force. They also interact frequently with other Powers... Great Powers are further differentiated from other states by others' images and perceptions of them."

"Finally, Great Powers are differentiated from others by formal criteria, including identification as a Great Power by an international conference, congress, organization, or treaty, or the granting of such privileges as permanent membership or veto power by an international organization or treaty."

Great Power status dynamics

States can acquire or loose Great Power status. During the 1495-1945 period 20 (core plus non-core) Great Power status changes can be determined (17, core only). Great Power status dynamics decreased linearly over time, implying an increasing ability of states to maintain their centrality in the System, and a linear increase in the structural stability of the System; Great Power status dynamics typically occurred during relatively stable periods and not during systemic wars. Status dynamics are a measure for the permanence of the status hierarchy – the structural stability – of the System.

Great Power System

I quote Levy (38): "A Great Power is defined here as a state that plays a major role in international politics with respect to security-related issues. The Great Powers can be differentiated from other states by their military power, their interests, their behavior in general and interactions with other powers' perception of them, and some formal criteria."

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Great Power war(s)

In his study "*War in the Modern Great Power System, 1495-1975*", Levy identified Great Power wars until 1975.

Levy (38) defines war conceptually as "a substantial armed conflict between the organized military forces of independent political units." Levy distinguishes between two subsets of wars: (1) wars involving Great Powers and (2) wars that "consists of wars with at least one Great Power on each side of the conflict. These wars are labeled Great Power wars." Levy operationalizes the criterion "substantial" by requiring a minimum of 1000 battle-deaths, defined as the number of deaths of military personnel. This number is not restricted to the Great Powers but includes all states, "even though these other states are not included in the actual measurements of the parameters of the war".

Growth, innovation, cycles, and the pace of life in cities

A number of regularities can be identified in the properties and dynamics of cities. Many diverse properties have been shown to be power-law functions of population size and can be categorized into distinct universality classes: "quantities reflecting wealth creation and innovation (increasing returns), and quantities accounting for infrastructure (economies of scale)." Both categories have certain limits to growth. Bettencourt et al. (11) argues "to ensure continued wealth creation in cities, and avoid stagnation, innovations must be introduced at an accelerating pace." A more or less identical dynamic – I refer to it the first finite-time singularity accompanied by four accelerating cycles (1495-1945) – can be identified in the war dynamics of the System. In the System organizational innovations must be implemented at an accelerating rate, to re-establish a certain balance and accommodate growth. Connectivity, as is the case for the System, plays a similar important role in the growth dynamics of cities. The research of Bettencourt et al. (11) and of Schläpfer et al. (56) provide useful clues to better understand the war dynamics and development of the System.

This section is based on research by Bettencourt et al. Bettencourt et al. made extensive use of insights in networks and complex systems to achieve a better understanding of "*growth, innovation, scaling, and the pace of life in cities*." The results of this research are discussed in a report with the same title (11).

Bettencourt et al. founded their research on the concept that "... the inexorable trend towards urbanization world-wide presents an urgent challenge for developing a predictive, quantitative theory of urban organization and sustainable development." The endemic occurrence of war in anarchistic systems in combination with the increasingly destructive power of available weapons, and the risks this involves , motivates this study, as discussed in the introduction of this study.

In their report, Bettencourt et al. discuss "empirical evidence indicating that the processes relating to economic development and knowledge creation are very general, being shared by all cities belonging to the same urban system and sustained across different nations and times. Many diverse properties of cities from patent production and personal income to electrical cable length are shown to be power law functions of population size with scaling exponents, β (beta), that fall into distinct universality classes."

Bettencourt et al. argue "cities are in fact scaled versions of one another, in a very specific but also universal fashion prescribed by a set of scaling laws." "Quantities accounting for infrastructure display economies of scale ($\beta \approx 0.8 < 1$), whereas those reflecting wealth creation and innovation have increasing returns ($\beta \approx 1.2 > 1$)." "Cities are – in other words – self-similar organizations, indicating a universality of human social dynamics, despite enormous variability in urban form." This universal behavior also "strongly suggests that there is a universal social dynamic at play that underlies all these phenomena, in extricable linking them in an integrated dynamical network, which implies, for instance, that an increase in productive social opportunities, both in number and quality, leads to quantifiable changes in individual behavior, across the full complexity of human expression, including those with negative consequences, such as costs, crime rates and disease incidence." There are "two distinct characteristics of cities revealed, resulting from fundamentally different, and even competing, underlying dynamics: (1) material economies of scale, characteristic of infrastructure networks, and (2) social interactions, responsible for innovation and wealth creation."

"Depending on the value of β (beta) of both categories, it is also possible to distinguish between two fundamentally different forms of growth: First, when $\beta < 1$ (related to material economies of scale, characteristic of infrastructure networks), growth leads to a sigmoidal growth curve, in which growth ceases at large times, as population approaches a finite carrying capacity. Social organizations that are driven by economies of scale are as a consequence destined to eventually stop growing. And secondly, when $\beta > 1$; in this case – when growth is driven by innovation and wealth creation – the character of the solution to the accompanying mathematical equation changes dramatically. In theory, there is unbounded growth potential, and there are no limitations to population size. However, growth becomes faster than exponential, eventually leading to an infinite population in a finite amount of time."

"This last form of growth behavior has powerful consequences, because, in practice, the resources driving this growth are ultimately limited, meaning that the singularity is actually never reached; thus, in other words, if conditions remain unchanged, unlimited growth is unsustainable. Left unchecked, this lack of sustainability will ultimately lead to stagnation and collapse."

"To avoid such a crisis, major qualitative changes must occur which effectively reset the initial conditions and parameters" of the system (to be more accurate: of the equation that describes this type of growth). "This means, the response to these limitations must be innovative to ensure that the predominant dynamic of the city remains in the wealth and knowledge creation phase where Beta > 1. This process, by which the initial conditions and parameters are being reset, can be continually repeated leading to multiple cycles, thereby pushing potential collapse into the future." "Major innovation cycles must be generated at a continually accelerating rate to sustain growth and avoid stagnation or collapse." Bettencourt et al. observed, "These conclusions very likely generalize to other social organizations, such as businesses, potentially explaining why continuous growth necessitates and accelerating treadmill of dynamical cycles of innovation." That indeed seems to be the case.

The properties of '*growth, innovation, scaling and the pace of life in cities*' (11), as reported by Bettencourt et al. show remarkable similarities with the war dynamics and development of the System during the period between 1495 and 1945. Both categories of systems, namely cities and international orders, need to innovate at an accelerating pace to sustain growth and avoid stagnation and collapse. Bettencourt et al. propose that population size (i.e., growth) drives this dynamic of cities: Schläpfer et al., show that a relationship exists between population size, connectivity, and the pace of life of systems (networks): Larger city populations imply increased connectivity that explain the observed accelerating dynamics.

Analysis shows that identical scaling relations can be identified between population size (of the System) and certain properties of war dynamics, as between the size of cities and particular properties of these cities.

In a related study titled "*The scaling of human interactions with city size*", Schläpfer et al. (56) investigate the relationship between the size of cities, which play a fundamental role in social and economic life, and the structure of the underlying network of human interactions. In their study, Schläpfer et al. address the question of what mechanisms underlie the super linear scaling of certain socio-economic quantities, such as properties of cities that were discussed in the previous paragraph.

In their study, Schläpfer et al. "explore the relation between city size and the structure of human interaction networks by analyzing nationwide communication records in Portugal and the United Kingdom." They show that "both the total number of contacts and the total communication activity grow super linearly with population size, according to well defined scaling relations and resulting from a multiplicative increase that affects most citizens." "These empirical results predict a systematic and scale-invariant acceleration of interaction-based spreading phenomena as cities get bigger which is numerically confirmed by applying epidemiological models to the studied networks."

For instance, Schläpfer et al. show that "the empirically observed network densification under constant clustering substantially facilitates interaction-based spreading processes, as cities get bigger, supporting the assumption that the increasing social connectivity underlies the super linear scaling of certain socio-economic quantities with city size." Schläpfer et al. observe, "The empirical quantities analyzed so far, are topological key factors for the efficiency of network based spreading processes, such as the diffusion of information and ideas or the transmissions of diseases. The degree and communication activity (call volume and number of calls) indicate how fast the state of a node may spread to nearby nodes, whereas the clustering largely determines its probability of propagating beyond the immediate neighbors." "Such an increase in the spreading speed is considered to be a key ingredient for the explanation of the super linear scaling of certain socioeconomic quantities with city size as, for instance, rapid information diffusion and the efficient exchange of ideas over person-to-person networks can be linked to innovation and productivity." This research further supports the prevailing hypothesis that "the structure of social networks underlies the generic properties of cities, manifested in the super linear scaling of almost all socio-economic quantities with population size." I assume that a similar mechanism (i.e., the increasing connectivity of the System) underlies the super linear scaling of certain properties of the war dynamics of the System, including the acceleration in frequency of the four cycles (i.e., systemic wars), which implies a shortening of the life span of successive cycles. Acceleration of the severities of the four successive systemic wars the System produced during the 1495-1945 period can also be observed.

Hierarchy

With the term dedicated non-anarchistic hierarchies I refer to the Western and Eastern non-anarchistic 'arrangements' that were implemented in the core of the System (Europe) through a phase transition, to achieve a lower energy state and to ensure compliance of the System with the second law of thermodynamics. The fourth systemic war, the Second World War (1939-1945) constituted the phase transition. The term 'hierarchy' points to the 'higher' level of organization of the 'arrangements'. The Western and Eastern hierarchy consisted of a number of states in respectively West and East Europa.

High-connectivity regime

Within the cascade window "global cascades can occur in two distinct regimes – a low connectivity regime and a high connectivity regime –corresponding to the lower and upper phase transitions respectively" (72).

In the low connectivity regime, "cascade propagation is limited by the connectivity of the network, a power law distribution of cascade sizes is observed, analogous to the cluster size distribution in standard percolation theory and avalanches in self-organized criticality." This means that the size of cascades in the low connectivity regime is determined by the connectivity of the network. When the connectivity increases, the size of cascades that the system produces also increases. However, at a particular stage, when a certain level of connectivity is reached, the size of cascades starts to decrease; cascade propagation now becomes limited not by a lack of connectivity, but instead by the local stability of the nodes themselves, which is caused by the increased connectivity of the network. At that stage, due to the high connectivity of the issue network, the effect of a new single signal (issue) becomes less significant.

During high-connectivity regimes the connectivity/local stability-effect limits the ability of the System to release free energy (tensions): Instead of being released, free energy (unresolved issues and tensions) is stored in the System, form a free energy release deficit and crystalize in vulnerable issue clusters with fractal structures. The moment these clusters percolate the System, the System becomes critical and produces a systemic war. Through systemic wars, the accumulated (stored) free energy is put to work to implement upgraded orders, that allow for lower energy states of the System (relatively stable periods).

During high-connectivity regimes the anarchistic System is 'charging' for a next systemic war.
See also: *Low-connectivity regime, Cascade dynamics, cascades triggered by shocks, Charging and Connectivity/local stability effect.*

High-connectivity war cluster(s)
During relatively stable periods (international orders) it is possible to distinguish low- and high-connectivity regimes limited by tipping points. Non-systemic wars that occur during low- and high-connectivity regimes, can be respectively grouped in low- and high connectivity war clusters. The development of these war clusters show remarkable regularities, consistent with the theory that is proposed in this study.

Hybrid/community warfare
See also: *Attrition warfare* and *Maneuver warfare.*

Hypercritical condition of the System
See: *Levels of criticality*

Illusion of control
See also: *Mass deception.*

Inertia
The anarchistic System derives its 'order' - structural stability and robustness - from what is sometimes referred to as 'inertia'; a resistance to change. In the deterministic domain of the System resistance to change is related to the System's connectivity. During relatively stable periods – international orders – of cycles of the finite-time singularity dynamic,

low- and high-connectivity regimes that are limited by tipping points, can be distinguished.

Once the tipping point of a relatively stable period (international order) is reached, and a high-connectivity regime determines the non-systemic war dynamics of the System, states become more stable as a consequence of their connectedness in the network of issues in the System. During the high-connectivity regime the local stability of the System – its resistance to change as it is interpreted – increases. The high connectivity of the System prevents the System from producing release events (non-systemic wars), and instead of being released free energy (tensions) build up in the System and crystallize in underlying vulnerable issue clusters. Eventually these vulnerable issue clusters percolate the System and cause the System to become critical and produce a systemic war. Systemic wars are 'used' by the System to implement upgraded orders, and ensure compliance of the System with the second law of thermodynamics.

The typical increase of the local stability and inertia of international orders during high-connectivity regimes, was especially evident before the outbreak of the First World War (1914-1918, the third systemic war). At that stage, the stability of the System (mis)led states, and their populations and decision makers to believe that war had become 'impossible'. As a consequence, the 'sudden' systemic response of the System (the third systemic war) became as a total surprise, historians still try to make sense of.

During high-connectivity regimes the System 'charges' itself to become critical, and to amass enough energy to accomplish a next upgrade.

Initial conditions, reset of -
See: *Lower energy state.*

Instability
The instability of the anarchistic System lies in the accelerating production of free energy (tensions) in the System, which is a consequence of the intrinsic incompatibility of (increasing) connectivity and security in anarchistic systems.
See also: *Fragility*, *Robustness*, *Stabilit*y, and *Structural stability*.

Integration
Integration is an integral component of the process of social integration and expansion (SIE) in the anarchistic System. During the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), states in the core of the anarchistic System (Europe) integrated, while at the same time these states expanded their control (and exploitation) to non-core territories. Both processes interacted and reinforced each other.

It was only a matter of time before non-core territories (that were increasingly modeled as states) developed their 'own' autonomous dynamics and rivalries.

The four (accelerating) cycles that accompanied the first finite-time singularity dynamic, correspondent with increasingly comprehensive levels of integration. In two 'directions' there was increasing integration: between states and between states and successive international orders.

The first three orders were implemented in an anarchistic 'context (within the anarchistic System). However, when in 1939 the core of the anarchistic System reached the critical connectivity threshold and produced infinite amounts of free energy as a consequence, the anarchistic core collapsed. The System in response produced a dual phase transition: Through the fourth systemic war (the Second World War, 1939-1945) two dedicated non-anarchistic hierarchies were implemented in the core of the System (Europe) and a first global order at a global scale of the System.

Intensity

Intensity is defined as the ratio of battle deaths to European population (Levy, (38)). I consider the intensity (as well as severity) of wars measures for the 'amount' of destructive energy (weapons, violence) that is deployed.

In a number of cases – I explicitly name – I use a somewhat different definition (measure) for intensity; in those particular cases I defined 'intensity' as the sum of the severities of a number of wars, divided by the time span of the period when these wars occurred.

Interacting self-fulfilling prophecies

In anarchistic systems states are responsible for their own security. In anarchistic systems one state's security often is another state's insecurity; this self-reinforcing mechanism also is referred to as the 'security dilemma'. In anarchistic systems states take precautions against potential threats. The problem in anarchistic systems is that these actions typically confirm perceived threats through the countermeasures that are taken by other states. Self-fulfilling prophecies 'interact' in anarchistic systems and reinforce each other.

Interactive' self-fulfilling prophecies constitute the 'interface' between the deterministic and contingent domain of the System. Free energy that is produced 'in' the deterministic domain 'crystalizes' and is 'shaped' in the contingent domain in networks of issues and accompanying tensions.
See also: *Interface between the deterministic and contingent domain of the System*.

Interdependence

States have become increasingly interdependent for the fulfillment of their basic requirements and survival. Population size (and growth), connectivity (growth), and interdependence are related phenomena. By interacting with other individuals and social systems (including states), and through integration (SIE) economies of scale and scope can be developed and exploited.

States also have become increasingly dependent on each other for their security; security can only be achieved if the requirements of other (often competing) states are taken into consideration.

The increasing far-reaching arrangements that were imposed on the anarchistic System through successive international orders (1495-1945) are a manifestation of the increasing security interdependence of states.

Interdependency paradox

Because of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems, an anarchistic system creates a paradox: On the one hand, increasing connectivity enables the development and exploitation of new/more economies of scale and scope that support the fulfillment of basic requirements by states and their populations, but on the other hand these interactions also produce issues and tensions between states. Over time, states became (and become) increasingly dependent on each other for the fulfillment of all their basic requirements, including their mutual security. At the same time as it became harder for states and their populations to live without each other, it also became harder to live with each other.

Through increasingly comprehensive international orders states tried to 'bridge' this paradox, but because the 'underlying' incompatibility (between connectivity and security in anarchistic systems) was not resolved, these orders only offered temporary solutions. The paradox was eventually resolved in parts of the core of the System through a phase transition (the fourth systemic war, The Second World War, 1939-1945) by implementing dedicated non-anarchistic hierarchies; however, the paradox was only resolved within respective hierarchies.

Interface (between the deterministic and contingent domain of the System)

Interacting self-fulfilling prophecies between states synchronize the dynamics between the deterministic and contingent domain of the System, and can be considered an interface. The interface consists of attractors around which tensions crystallize; vulnerable issue clusters are the product of this interactive crystallization process. Attractors are issues that rival states and populations interactively create and use to justify the production and deployment of destructive energy.

See also: *Interactive (or collective) self-fulfilling prophecies.*

Internal inhibition of chaotic non-systemic war dynamics; internal control provided by chaotic (n > 2) conditions

Chaotic conditions ($n > 2$) provide the anarchistic System with an 'internal control mechanism' that ensures that non-systemic war dynamics do not become hyper-excited, or too subdued. Chaotic conditions – and chaotic non-systemic war dynamics it results in – allow the System to grow (crystallize) underlying vulnerable issue clusters with fractal structures during high-connectivity regimes of relatively stable periods, that cause the System to eventually become critical, produce systemic wars, and upgrade its order to allow for a lower energy state (tension-levels) of the System.

International order

'International order' refers to the organizational arrangements between states in the anarchistic System concerning security, and security related issues. Four international orders can be distinguished during the 1495-1945 period. International orders need periodic adjustment to ensure their continued functioning. International orders are typically implemented through Systemic war. The function of international orders is to enable the fulfillment of basic requirements by uneven and competing states that have different interests and power positions. Depending on the stage of development of the System (order), organizational arrangements can consist of certain implicit or explicit rules that are more or less restricting the freedom of action of states. These rules can concern different domains. Arrangements also include institutions and coordination mechanisms, like meeting structures.

Over time, successive international orders became more comprehensive for states, and increasingly limited their freedom of (accepted) action.

Presently the System is in its fifth international order; the first global international order. In 1939 the anarchistic System reached the critical connectivity threshold, and collapsed as a consequence. In response – to ensure compliance with the second law of thermodynamics – the System experienced a 'dual' phase transition: At the same time (1945) when two dedicated non-anarchistic hierarchies were implemented in Europe – which over time had become the core of an increasingly expanding System (outside of Europe, initially through colonization) – the first global order was implemented at a global scale of the System. The order that was established in Europe (two non-anarchistic hierarchies) was an integral component of the first global order.

Intrinsic incompatibility of (increasing) connectivity and security in anarchistic systems

Interactions between states in the anarchistic System expose contradictions in (the fulfillment of) their basic requirements; these contradictions result in the production of tensions (free energy) in the System. Population growth and increasing interdependence of states not only contribute to the connectivity, and the interactions and the fulfillment of basic requirements of states, but also to the increasing production of tensions in the anarchistic System. These tensions negatively affect the sense of security of states and their populations in the anarchistic System. Tensions are further reinforced – magnified and 'shaped' – by the security dilemma and interacting self-fulfilling prophecies between states. These 'mechanisms' and their dynamics, I refer to as the intrinsic incompatibility between connectivity and security in anarchistic systems.

The intrinsic incompatibility between connectivity and security in anarchistic systems is at the heart of both finite-time singularity dynamics.

Issue (s), Issue clusters, Vulnerable issue clusters
Issues between states concern matters, affairs and controversies (including conflicts) between states with (potential) security implications or effects.

Issues impact – or can impact – on the security requirements, real or perceived, by states. Issues are related to the fulfillment of basic requirements by states. Issues (potential and manifest) can be – or become – connected and form dynamic networks that need continuous monitoring by states. States in the System are connected through issues. A quality of issues is that issues are accompanied by tensions between states. Tensions are manifestations of free energy in the contingent domain, that can be 'transformed' in destructive energy and result in alliance dynamics.

Issues (in the contingent domain) are (further) shaped by the security dilemma and interacting self-fulfilling prophecies between states. Issues crystallize into underlying vulnerable issue clusters, and become crystallization points to which destructive energy is attracted. An issue (cluster) is vulnerable when it is one step from being activated into a war (cascade).

Issue clusters
See: *Issue (s), Issue clusters, Vulnerable issue clusters.*

Latitude for contingent dynamics
The deterministic domain determines the latitude – 'playing field' – of the contingent dynamics of the System. Deterministic laws (for example), determine *when* the anarchistic System becomes critical and produces a systemic war, the *duration* of critical periods, and *how much energy* must be put to work to implement upgraded orders that allow for lower energy states of the System. What issues wars are fought for, and how they are fought is a matter of contingency, as long as the deterministic demands of the System are met.

Levels of criticality; conditions of the System
It is possible to distinguish between different 'levels of criticality'. In this (and other) research the following terminology is (sometimes) used to qualify the nature of the condition (and accompanying) dynamics of a system: critical, subcritical, hypercritical and subdued (a term I introduced to qualify a certain type of war dynamics in the System, during the second exceptional period (1953-1989)).

Condition of the System 1495-present			
	n	Type of war dynamics	Periods
Critical	> 2	Chaotic	- 1618-1648 - 1792-1815 - 1914-1918 - 1939-1945
Subcritical	> 2	Chaotic	- 1495-1618 - 1648-1657 - 1763-1792 - 1815-1914 - 1918-1939 - 1945-1953 - 1989-present
Hypercritical	2	Periodic, hyper-excited	- 1657-1763
Subdued	2	Subdued	- 1953-1989

Table 127 *This table shows the different types of conditions that can be distinguished in the System during the period 1495-present.*

Level of metastability
See: *Metastability*, *Energy state of the System*.

Life cycle of cycles (oscillations)
During the 1495-1945 period the anarchistic System produced a finite-time singularity dynamic which was accompanied by four accelerating cycles. Each cycle consisted of a relatively stable period (international order in the contingent domain) followed by a short critical period (systemic war).

Two regimes can be distinguished during relatively stable periods: respectively a low- and high-connectivity regime, divided by a tipping point. During low-connectivity regimes increasing connectivity of the issue network, results in increasingly larger sized non-systemic wars. Once the tipping point and high-connectivity regime is reached, the connectivity/local stability effect causes the sizes of non-systemic wars to decrease. During high-connectivity regimes free energy (tensions), is not released but increasingly stored in the System. The stored free energy (unresolved issues and tensions) forms a free energy release deficit, that crystallizes in vulnerable issue clusters with fractal structures. Once these vulnerable issue clusters percolate the System, the System becomes critical and produces a systemic war. Through systemic wars the anarchistic System implements upgraded orders that allow for lower energy states in the System.

Limit cycle(s)
"If an oscillatory system with a locally unstable equilibrium is given a slight nudge off its equilibrium point, its swings grow larger and larger until they are constrained by various nonlinearities." Such oscillations are known as limit cycles to denote the nonlinear limits restricting their amplitude. In limit cycles, the states of the system remain within certain ranges as they are limited to a certain region of state space. In the steady state, after the effects of any initial perturbations have died out, a limit cycle follows a particular orbit (closed curve) in state space." The steady state orbit is, in other words, the attractor since trajectories adjacent enough to it will move toward it."
See also: *Oscillation(s)*.

Local stability
Local stability refers to the phenomenon that at a certain point (the tipping point of relatively stable periods), (increasing) connectivity of issue clusters (of which states are integral parts) make states more 'stable' - more 'reluctant' - to switch to positive war decisions. The effect is local, because it affects states (nodes) in the network. If more (all) states become more 'locally' stable, the System itself becomes more stable. This effect I also refer to as the 'connectivity/local stability effect', and enables the storage and crystallization of unreleased free energy; a precondition for the System to become critical.

The assumption is that war decisions qualify as binary decisions with externalities and thresholds. The moment the System is in a high-connectivity regime; incoming signals regarding issues have less impact on the decisions of states. I will explain the connectivity/local stability effect with an example. I assume that a state applies a decision-rule that it will switch to a positive war decision if a fraction of 6/10 of its connections (incoming signals) related to the issue also switch to war. I assume that in the low-connectivity regime (of this example) the state in question has 10 connections, and 5/10 of its connections are positive (towards war); the moment a sixth connection switches to war, the state will also switch to war.

In case of a high-connectivity regime the state in question has 100 connections, and applies the same decision rule. I assume that 50/100 of the state's connections are positive towards war; that is same fraction (decision rule) as in above (low-connectivity) scenario. Given this situation, the moment a next incoming signal switches to war, the fraction will become 51/100, and the state in question will not switch to war; the threshold to switch (6/10) is not yet reached.

Because of the connectivity of states (nodes) in the issue network during high-connectivity regimes, incoming signals loose significance, and states become 'locally' more stable as a consequence.

Lock-in
See: *Path dependence*.

Low-connectivity war cluster(s)

During relatively stable periods (international orders) it is possible to distinguish low- and high-connectivity regimes limited by tipping points. Non-systemic wars that occur during low- and high-connectivity regimes, can be respectively grouped in low- and high connectivity war clusters. The development of these war clusters show remarkable regularities, consistent with the theory that is proposed in this study.

Low-connectivity regime

Within the cascade window "global cascades can occur in two distinct regimes – a low connectivity regime and a high connectivity regime –corresponding to the lower and upper phase transitions respectively." In the low connectivity regime, "cascade propagation is limited by the connectivity of the network, a power law distribution of cascade sizes is observed, analogous to the cluster size distribution in standard percolation theory and avalanches in self-organized criticality." This means that the size of cascades in the low connectivity regime is determined by the connectivity of the network. When the connectivity increases, the size of cascades that the system produces also increases. However, at a particular stage, when a certain level of connectivity is reached, the size of cascades starts to decrease; cascade propagation now becomes limited not by a lack of connectivity, but instead by the local stability of the nodes themselves, which is caused by the increased connectivity of the network. At that stage, due to the high connectivity, the effect of a new single signal becomes less significant (72).
See also: *High-connectivity regime* and *Cascade dynamics, cascades triggered by shocks.*

Lower energy state

In accordance with the second law of thermodynamics free energy – tensions in the System – are periodically put to work through systemic wars, to implement upgraded orders that allow for lower energy states of the System.

When the System implements upgraded orders (typically through systemic wars) that allow for lower energy states, not only is the level of tension in the System lowered (implying a reset of its conditions), but also is the System's ability to restrain/control higher levels of tension, enhanced (implying a reset of the parameters of the System). Successive international orders during the first finite-time singularity dynamic which was accompanied by four accelerating cycles (1495-1945), were increasingly robust; however, this property became at a price: successive orders were also increasingly fragile.

Lyapunov exponent

A typical characteristic of chaotic dynamics is their sensitive dependence for initial conditions, which indicates that two almost similar initial conditions will develop differently and produce two completely different trajectories (orbits) in phase state. Sensitive dependence for initial conditions makes accurate predictions impossible.

The Lyapunov exponent is a measure of the rate of spread of two trajectories that originate from nearby initial conditions. "The Lyapunov exponent is defined as the average rate of trajectory divergence caused by the endogenous component (and not by stochasticity), using for its calculation two trajectories that start near one another and that are – this is an important assumption – affected by an identical sequence of random shocks" (28). A positive exponent is supposedly an indicator of chaos.

Maneuver warfare
See also: *attrition warfare* and *hybrid/community warfare*.

Metastability
The ability of the anarchistic System to stay for an extended time in an order (configuration) other than the System's state of least energy is indicative for its metastability. The fact that the System could (and can) maintain itself 'in' relatively stable periods (international orders), when free energy (tensions) continuously and at an accelerated rate builds up in the System, is indicative for the metastability of the System. The System's metastability increases during high-connectivity regimes as a consequence of the connectivity/local stability effect, and is a prerequisite for the System to become critical, and produce systemic wars. Metastability is a prerequisite for the development of a finite-time singularity dynamic.
See also: *Energy state*.

Modes of behavior of dynamical systems
Sterman (69) describes three common modes of behavior: exponential growth, goal seeking, and oscillations.

1 ***Exponential growth***
"Exponential growth arises from positive, self-reinforcing feedbacks. The larger the quantity, the greater its net increase, thereby further augmenting the quantity and leading to ever-faster net growth. The growth rate, however, is constant. Exponential growth is characterized by a constant doubling time; the state of the system doubles in a fixed period of time regardless of its size. Positive feedback need not always generate growth; it can also create a self-reinforcing decline."

2 ***Goal seeking***
"Whereas positive feedback loops generate growth, amplify deviations, and reinforce change, negative loops seek balance, equilibrium, and stasis. Negative feedback loops act to bring the state of the system in line with a goal or a desired state." Systemic wars bring, with a certain delay, the state of the System in line with a desired state. The desired state is a new order

or a new balance in which uneven states can collectively compete for the fulfillment of their basic requirements in an anarchistic environment. The desired state, the new order, is the goal or purpose of a systemic war. Every negative loop includes a process to compare the desired and actual conditions and take corrective action. In most cases, the rate at which the state of the system approaches its goal diminishes as the discrepancy falls. The gradual approach arises because large gaps between desired and actual states tend to generate large responses, while small gaps tend to elicit small responses."

This logic also applies to the System. During the unfolding of the finite-time singularity dynamic (1495-1945) the discrepancy between the actual and desired state (condition) of the System increased over time, generating ever larger responses through increasingly severe and intense systemic wars.

Through a finite-time singularity dynamic, the System produced four systemic wars during the period 1495–1945; all four systemic wars produced a new order. The first three systemic wars produced only temporary solutions in response to the disorder produced by connectivity growth in the anarchistic System. However, these three solutions (new orders) did not change the fundamental, anarchistic nature of the System (for the simple reason that this was not necessary for the System to comply with the demands of the second law of thermodynamics, at that stage). However, when in 1939 the connectivity of the System reached the critical threshold, a phase transition had become unavoidable. The fourth systemic war (the Second World War, 1939-1945) constituted the phase transition.

At the critical point in 1939, the incompatibility between increasing connectivity and security (i.e., the gap between the desired and actual state of the anarchistic system) could not be bridged any longer by implementing an upgraded order within the anarchistic system.

3 *Oscillation*

Oscillation is the third fundamental mode of behavior observed in dynamic systems. Instead of the term 'oscillation' I mostly use the term '*cycle*.' In this study, these terms are considered synonyms. Like goal-seeking behavior, oscillations are caused by negative feedback loops. "The state of the system is compared to its goal, and corrective actions are taken to eliminate any discrepancies. In an oscillatory system, the state of the system constantly overshoots its goal or equilibrium state, reverses, then undershoots, and so on. The overshooting arises from the presence of significant time delays in the negative loop. The time delays cause corrective actions to continue even after the state of the system reaches its goal, forcing the system to adjust too much, and triggering a new correction in the opposite direction."

There are many types of oscillation, including damped oscillations, limit cycles, and chaos. Each variant is caused by a particular feedback structure and set of parameters determining the strength of the loops and the length of the delays. In case of the System, its connectivity and thresholds contributed to the four (accelerating) oscillations that accompanied the finite-time singularity dynamic (1495-1945). The connectivity of the System determined the pace of life and the spreading speed of information in the System; including the spread of tensions in the System. Meanwhile, thresholds determined the level of inertia of the System. The System was (and is) a growing and evolving system. The connectivity of the System and its thresholds (the control parameters of the System) constantly increase, contributing to an acceleration in the frequency of successive oscillations.

Sterman observes, that most real-world oscillations are not perfectly regular: “Biological, social, and economic systems involve huge numbers of interactions among tightly coupled elements. They are continuously bombarded by perturbations that cause their motion to be somewhat irregular, a (usually nonlinear) combination of their endogenous dynamics and these exogenous shocks.”

As Sterman explains, “system dynamics arise from networks of positive and negative feedbacks, and how they interact with one another. The existence of various feedback loops in a system does not mean that all of them have the same impact on the dynamics of the system. The dominance of loops (positive and negative) can vary and shift.” Sterman observes, “Identifying potential shifts in loop dominance arising from latent structures is a valuable function of modeling.”

In the System, such a shift in loop dominance can also be observed. Normally, during the life span of relatively stable periods, a self-reinforcing (positive feedback) loop dominates its dynamics of the System. The connectivity of the System and the rivalry between states continually increase, producing issues and tensions, and causing the buildup of destructive energy. These variables also constitute a self-reinforcing mechanism (the security dilemma), a mechanism that also contributes to higher levels of tension in the System. As a consequence, the System reaches a critical point and produces a systemic war. Through a systemic war, the System creates new order and finds a new, at least temporarily effective, balance. The moment the System produces a systemic war, the negative feedback loop has become dominant. The dominant behavior of the System is now goal seeking; the System eliminates, through collective action (systemic war), discrepancies between a dysfunctional disordered state that has developed over time, and a desired (ordered) state that must ensure more efficient fulfillment of basic requirements. A shift in loop dominance occurred in 1618, 1792, 1914, and 1939; each time a systemic war was produced by the anarchistic System.

Military organizations

Military organizations are self-similar – fractal – structures; military units typically consist of a number of sub-units with similar structures. Military organizations are responsible for the deployment of destructive energy during wars. Not only are the structures as such fractal, but also the range and destructive power of destructive energy that can be deployed at different levels of organization.

The destructive potential and reach of capabilities developed over time, starting with individual – personal – weapons, with limited capability in terms of lethality and range), followed by weapons with ever-greater destructive power, and range; ultimately resulting in nuclear weapons, with global – intercontinental – range. The growth of destructive power and range did go hand-in-hand with the growth of (the size of) military organizations.

State formation, the narrowing down of competition between states to maximizing military potential, network structures of (military) organizations and the fractal organization of armies (etc.), were closely related - co-evolving phenomena, and were (highly) contingent of the particular conditions that prevailed in Europe, during the 1495-1945 period.

Multi-level optimization

The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) can be considered a 'multi-level' optimization dynamic that ensured that the dynamics of the System were simultaneously optimized at different 'levels' of the System.

Four levels can be distinguished in the dynamics of the System: (1) the level of the finite-time singularity dynamic, which was accompanied by four accelerating cycles (level 2), (3) the level of 'orbits' that make up circular trajectories in phase state, each orbit consisting of a number of non-systemic wars, and (4) the level of non-systemic wars.

These multi-level optimization dynamics interacted, and were synchronized. The singularity dynamic can be considered an optimal 'balance' between relative structural stability and change, and between 'performance' and 'evolvability' of the System.

Mutual Assured Destruction (MAD)

Mutual Assured Destruction refers to the 'second strike capability' of the United States and the Soviet Union during the second exceptional period (1953-1989, better known as the 'Cold War'). Both superpowers had ensured through protective measures, precautions, organization and strategies, etc. that under all conditions – including a first nuclear strike from their rival – enough nuclear capabilities would survive, to launch a retaliatory nuclear strike. Mutual destruction was under all conditions assured, and resulted in a deadlock.

As a consequence, war as an instrument of policy/politics had lost its 'logic' and function. This situation produced a deadlock because of the risks of escalation. Because of the risks involved, including self-destruction, both superpowers were very reluctant to confront each other directly. As far as non-systemic wars occurred during the period 1953-1989, they were very subdued, and took (for one exception) place outside of the primary focus of the rivalries (Europe).

Mutual empowerment
Mutual empowerment is a mechanism that contributed to the selection of the state as the dominant unit in the anarchistic System. States, by empowering units in the System with similar structures (that is state-structures), ensured that interactions between units (states) could be better controlled and regulated, and also became more predictable.

The selection-criteria that were imposed by dominant states were embedded in organizational arrangements that underpinned successive international orders. Mutual empowerment of actors can be considered a form of self-selection.

Because the European (state) System was increasingly based on a uniform logic of organization, competition between (increasingly standardized) states increasingly 'narrowed' - focused - on the ability of states to develop, produce, mobilize and deploy superior amounts of destructive energy. Particular attributes (war fighting) were – so to say – enhanced to the extreme. Mutual empowerment contributed to the increasing totality of successive systemic wars.

Non-chaotic (abnormal) non-systemic war dynamics
See: *Abnormal (non-chaotic) non-systemic war dynamics.*

Non-systemic release event
During the unfolding of the first and second singularity dynamics (respectively 1495-1945 and 1945-...) two types of energy releases can be distinguished in the deterministic domain of the anarchistic System: systemic and non-systemic release events that correspondent respectively with systemic and non-systemic wars in the contingent domain of the System. Release events – systemic and non-systemic – obey the second law of thermodynamics. Systemic release events (systemic wars) are equivalent with criticality of the System.

Non-systemic war
Non-systemic wars are manifestations of non-systemic energy releases in the contingent domain of the System. Non-systemic wars – contrary to systemic wars – concern 'local' incompatibilities' between states; non-systemic wars are not about upgrading the order of the System. Specific characteristics of non-systemic wars are: (1) their intrinsic unpredictability because of their chaotic nature, (2) their (mostly, when chaotic conditions prevail) more limited size, and (3) the absence of a (direct) impact on the order(ing) of the System. See also: *Systemic war.*

Optimization
With optimization I refer to a process of 'balancing' of two or more (partially) contradicting demands or properties of the System; for example, of the performance and evolvability of the anarchistic System. To achieve an optimal result certain trade-offs must be made.

I assume that except for the abnormal war dynamics of the System during the first exceptional period (1657-1763), the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) was a highly optimized dynamic that ensured that population growth in the core of the System could be maximized under the prevailing (anarchistic) conditions.

Order

Order refers to the organization, the structure of the System (the network). It is possible to make a distinction between the order of the System in the deterministic and contingent domain of the System. The order in the contingent domain, I refer to as the 'international order of the System. Order provides a certain (structural) stability, to the System; other properties of the order are its robustness and fragility.

The order of the System is more or less functional. Performance of the System (of its order at a certain point in time) is a measure of its functionality; that is, its ability to fulfill the basic requirements of uneven states in the anarchistic System.

The order of the System is periodically upgraded to allow for a lower energy state and ensure compliance with the second law of thermodynamics. Orders are upgraded through systemic wars; through systemic wars free energy is put to work, to upgrade the order of the System to allow for a lower energy state and for a new relatively stable period.

During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the anarchistic System four times upgraded its order. The fourth systemic war (the Second World War, 1939-1945) constituted a dual phase transition when the System simultaneously implemented two dedicated non-anarchistic hierarchies in the core of the System and the first global order at a global scale of the System.

Order parameter

An order parameter describes a specific aspect of the state – condition – of a system. The level integration in the System concerns an order parameter of the System.
See also: *Control parameter.*

Ordered regime

See: *Regimes of behavior of Boolean networks.*

Optimization and fractality

Fractals in dynamics and structures of the System, as is the case with fractals in biological systems, point to optimization. It seems that in all these cases 'distribution' is involved, and the System must reconcile contradictory requirements.
See also: *Optimization of performance and evolvability.*

Optimization of performance and evolvability

Jensen et al. (32) argues that "Spatial fractals and fractal time series are ubiquitous in nature. Despite intensive study very little is known about why fractals are formed." Jensen poses the question: "What aspects of the evolution or dynamics of macroscopic systems are responsible for the formation of fractals?" Jensen also suggests "that the principle of lowest energy selects these fractal structures." I assume that the same free energy principles produce fractal activities and structures in the System, and that fractals in fact are optimal solutions to contradictory requirements that the System (the singularity dynamic) must reconcile.

Bettencourt et al. (11) observe, in relation to fractals: "Highly complex, self-sustaining structures, whether cells, organisms, cities require close integration of enormous numbers of constituent units that need efficient servicing."

"To accomplish this integration," Bettencourt et al. continue, "life at all scales is sustained by optimized, in some cases space filling, hierarchical branching networks (*IP, that means structures with fractal properties*) which grow with the size of the organism as uniquely specified approximately self-similar structures." "Because these networks, e.g. the vascular systems of animals and plants, determine the rates at which energy is delivered to functional units (cells), they set the pace of physiological processes as scaling functions of the size of the organism." It is the "self-similar nature of resource distribution networks, common to all organisms, that provides the basis for a quantitative, predictive theory of biological structure and dynamics, despite much external variation in appearance and form."

Bettencourt et al. relate these observations to biological and social systems. "From this perspective, it is natural to ask whether social organizations also display universal power law scaling for variables reflecting key structural and dynamical characteristics." This line of thought is at the basis of Bettencourt et al.'s study of "*Growth, innovation, scaling, and the pace of life in cities*" (11).

West et al. also point to the relationship between selection and optimization. "Natural selection has tended to maximize both metabolic capacity, by maximizing the scaling of exchange surface areas, and internal efficiency, by minimizing the scaling of transport distances and times" (75).

I argue, consistent with Bettencourt et al., that states and the System also require close integration and assume that fractal structures that can be found in the System and its dynamics are closely related to 'efficient servicing' of the System (balancing, and adaptation). Consistent with West et al. and as discussed by Kauffman (36), I assume that these fractal structures are the outcome of a selection process, and that selection and self-organization have maximized both (1) the ability of the System to balance competing interests and minimize tension (free energy) production and adapt to changing conditions (increasing connectivity) by maximizing the scaling of exchange surface areas and (2) internal efficiency by minimizing the scaling of transport distances and times.

It should be kept in mind that balancing and adaptation is achieved by deploying destructive energy at all scales. The deployment of destructive energy can be considered as a distribution process that can, in principle, be optimized according to the same logic and trade-offs as other processes of life.

Optimum order

During the 1495-1945 period the anarchistic System produced a finite-time singularity dynamic accompanied by four accelerating cycles; because the System produced free energy at an accelerating rate, upgraded orders had to be implemented at an accelerating pace, to ensure consistency with the second law of thermodynamics.

Through a self-organized finite-time singularity dynamic accompanied by four accelerating cycles, the anarchistic System ensured an optimal balance between order and disorder. This optimum order ensured an optimal balance between the performance of the System and its evolvability. Performance refers to the ability of the anarchistic System to fulfill the basic requirements of uneven and (increasingly) interdependent states in the anarchistic System, and evolvability to the System's ability to adapt timely to the increased connectivity of the System and higher levels of free energy (tensions), by implementing upgraded orders through systemic wars.

I argue that the optimum order of the anarchistic System during the 1495-1945 period, ensured maximal population growth, by ensuring – by striking – an optimal balance between order and disorder, and performance and evolvability. During the 1495-1945 period the population in Europe (the core of the anarchist System) increased from circa 83 million in 1495 to 544 million in 1945.

Oscillation

Like goal-seeking behavior, oscillations are caused by negative feedback loops: The state of the system is compared to its goal, and corrective actions are taken to eliminate any discrepancies. In an oscillatory system, the state of the system constantly overshoots its goal or equilibrium state, reverses, then undershoots, and so on. The overshooting arises from the presence of significant time delays in the negative loop. Oscillation is a fundamental mode of behavior observed in dynamic systems.

A number of oscillations can be observed in the dynamics of the System, including:

1 *The finite-time singularity dynamic (1495-1945)*

The first finite-time singularity dynamic was accompanied by four accelerating oscillations (cycles). Systemic wars are corrections of the anarchistic System to re-establish a functional level of order; these corrections were however delayed, because the System tried to keep a certain balance through international orders (ensure its performance). The acceleration of the oscillations – of systemic wars – can be attributed to the accelerating growth rate of free energy (tensions) in the System. Upgraded orders had to be implemented at an accelerating rate to ensure compliance with the second law of thermodynamics.

2 *The first international order (1495-1618)*
During the first international order the anarchistic System produced 45 non-systemic wars. These wars were chaotic in nature and produced nine orbits (circular trajectories) in phase state. Analysis shows that these nine orbits constituted a damped oscillator. It shows the efforts of the System – although with delays – to re-establish order during the first relatively stable period. The damping effect was caused by the connectivity/local stability effect, during the high-connectivity regime of the first international order (1495-1618).

Pace of life
The pace of life of the System is a function of its connectivity, itself a function of population size. The pace of life of the System determines the spreading speed of information and tensions. The acceleration of successive cycles that accompanied the finite-time singularity dynamic (1495-1945) is indicate for the System's increasing pace of life, and a function of population growth during that period.

Parallel processing system
Boolean networks are parallel processing systems: the nodes of such networks (systems) process information simultaneous, and can perform different tasks simultaneous (36). The System can also be considered a parallel processing system: states in the System simultaneously process information, for example, to assess if the fulfillment of their basic requirements still is ensured

Parameters, reset of-
See: *Lower energy state.*

Path dependence (and lock-in)
"Path dependence is a pattern of behavior in which small, random events early in the history of a system determine the ultimate end state, even when all end states are equally likely at the beginning. Path dependence arises in systems whose dynamics are dominated by positive feedback."

"Path dependence is a pattern of behavior in which the ultimate equilibrium depends on the initial conditions and random shocks as the system evolves. In a path-dependent system, small, unpredictable events early in the history of the system can decisively determine its ultimate fate. The eventual end state of a path-dependent system depends on the starting point and on small, unpredictable perturbations early in its history. Even when all paths are initially equally attractive, the symmetry is broken by microscopic noise and external perturbations. Positive feedback processes then amplify these small initial differences until they reach macroscopic significance. Once a dominant design or standard has emerged, the costs of switching become prohibitive, so the equilibrium is self-enforcing: the system has locked in."

"Path dependence arises in systems with locally unstable equilibria," "also termed a repellor because nearby trajectories are forced away from it." Although the initial local equilibrium is unstable, the system as a whole must be stable.

"Microscopic differences in initial conditions lead to macroscopic differences in outcomes." Lock-in is another feature of path dependence. Initially, the trajectory, or direction of development, of the system is relatively flexible and can still change direction. However, it is a matter of time and the system becomes progressively locked in. The measure of lock-in of system determines the costs (e.g., energy) that are required to change its path. Based on: Sterman (69).

Percolation or cascade condition

The percolation threshold of a relatively stable period of the anarchistic System is reached when vulnerable issue clusters connect and span the System; at that point (at the percolation threshold) a vulnerable issue cluster includes all Great Powers of the System.

If this is the case, the correlation length of the System equals one, and the System is critical; that is, a positive war decision of a single state will trigger similar decisions in the whole network. This domino effect causes a system-wide cascade. Therefore, percolation conditions, criticality, a correlation length of one, and systemic wars go hand in hand.

Percolation threshold

In 1495 'units' (predecessors of states) in Europe became sufficiently connected to form a coherent system. In 1495 'Europe' reached the percolation threshold, and all units were – or could be – connected, and (in)directly interact or influence each other.

Performance

Performance refers to the ability of the System to ensure the balanced fulfillment of basic requirements of uneven states in the anarchistic System. Performance is closely related to the System's *evolvability*.

Periodic dynamics

In case of periodic dynamics, a particular pattern of behavior repeats itself. During the first exceptional period (1657-1763) the System produced doubly periodic non-systemic war dynamics.
See also: *Doubly periodic non-systemic war dynamics.*

Periodic window

The term periodic window is associated with the transition (of systems) to chaos (chaotic dynamics). Systems/dynamics that make a transition to chaos show that chaos does not continue uninterrupted, but that various periodic windows emerge (23). During 'periodic windows' dynamics are periodic in nature.

I assume that during the first exceptional period (1657-1763), the System temporarily 'fell back' in a periodic window as a consequence of a (temporary) reduction in the number of degrees of freedom of the System to two (as a consequence of the intense rivalry between Britain and France).
See also: *Doubly periodic non-systemic war dynamics.*

Phase transition

This explanation of phase transitions is mainly based on a study by Richard V. Solé titled: 'Phase Transitions' (61), unless otherwise stated. Solé explains "many important problems of complexity are related in one way or another with the presence of phase transitions. Most complex systems are known to potentially display a number of different patterns of qualitative behavior or phases." "Such phases correspond to different forms of internal organization and two given phases are usually separated by a sharp boundary, and crossing such a frontier implies a change in system-level behavior." "Understanding these potentially catastrophic changes is crucial for the future of our society as well."

Phase transitions occur because systems can lower their free energy by introducing a 'new' order. All systems, including the System, obey the second law of thermodynamics, which states that all processes occur in order to minimize the overall free energy. I refer to this principle as the 'principle of free energy.' The free energy ('tensions') that is produced by the System will at a certain stage be put to work; it is just a matter of time.

Populations and connectivity growth in the System and rivalry between states create issues and tensions. In reaction to these issues and tensions, along with the positive feedback effects of the security dilemma, states build up destructive energy that is stored in the System. This destructive energy constitutes the free energy of the anarchistic System. This free energy (destructive power) is converted to work during systemic wars, and used by the System (states) to introduce new order to minimize the level of free energy. Systemic wars are 'ordering forces.'

Typically, the basic properties of a system near a phase transition have nothing to do with the microscopic details of the system: "It doesn't matter whether we are dealing with a liquid- gas transition, a structural transition where a crystal deforms, or a magnetic transition where the little magnets or spins start pointing in the same direction" (5).

Phase transitions are also known to occur in social systems. Transitions between different macroscopic patterns of organization that characterize phases emerge out of interactions between the components of the system. In the case of the System, states are the components of the system that interact.

In physics, phase changes are often tied to changes between order and disorder as a control parameter (e.g., temperature) of the system is tuned. Such phase transitions cause at a certain point a change in an order parameter in the internal symmetry of the components. A transition from liquid (water) to a solid structure (ice) is an example of a change in the order parameter of the system. I assume that 'connectivity' is the control parameter of the System, and that the 'transition' from 'anarchy' to two dedicated non anarchistic hierarchy(s) constituted a change in the order parameter of the System, that took place at the critical point of the System (through the fourth systemic war, the Second World War, 1939–1945).

Real systems, and simulations with the Ising model, show that systems at a critical point exhibit wide fluctuations in its order parameter which are more 'extreme' than would be expected from a system at or close to equilibrium. Increasingly 'extreme' fluctuations can also be observed in the systemic war dynamics of the System, when the System 'approached' the critical connectivity threshold (and ultimately reached the critical connectivity threshold in 1939) and experienced a phase transition as a consequence.

The so-called 'systemic wars,' along with their accelerating frequency and strength, are manifestations of these fluctuations, and integral 'parts' of the four oscillations (cycles) that accompany the singularity dynamic that unfolded during the period of 1495–1945. The singularity dynamics and accelerating cycles that accompany it were produced unintentionally, without design, and qualifies as a self-organized dynamic. Systemic wars are instrumental in the periodic rebalancing of the System, and in the implementation of upgraded international orders that provide (temporary) structural stability to the System.

A phase transition is a system-wide change that requires collective action to be accomplished by the components of the system: "Transition phenomena are collective by nature and result from interactions taking place among many interacting units." Typically, interaction between states during systemic wars (that is, at the critical point) are system-wide and very intense. Through a collaborative self-organized process, states destroy issues and tensions, and then design and implement a new order to achieve a new balance that enables the fulfillment of basic requirements by all states.

The Ising model is a simple model of critical behavior, and it was soon realized that it provides a powerful framework for understanding different phase transitions using a few fundamental features. I will give a short explanation of this explanatory model.

"Iron atoms have a natural tendency to align their spin – having just two possible states: –1 (down) and +1 (up) – with their neighboring atoms in the same direction. If a 'down' atom is surrounded by 'up' neighbors, it will tend to adopt the same 'up' state. The final state would be a lattice with only 'up' or ‘down’ units. This defines the ordered phase, where the magnetization either takes the value M = 1 or M = –1.

“The Ising model is based on the observation, that if we heat a piece of iron (implying, that in this example, temperature is the control parameter) to high temperatures, then no magnetic attraction is observed. This is due to the fact that thermal perturbations disrupt atomic interactions by flipping single atoms irrespective of the state of their neighbors. If the applied temperature is high enough, in other words, then the atoms will acquire random configurations, and the global magnetization will be zero. This defines the so-called disordered phase.” Solé explained that “the ‘problem’ involves a conflict between two tendencies: the first toward order, associated to the coupling between nearest atoms, and the second toward disorder, due to external noise.”

Beggs et al. (10) described the dynamics of the Ising model of systems at criticality as follows: a phase transition is in fact always a ‘conflict’ between order and disorder; as is the case in this particular example. At high temperatures thermal fluctuations dominate over nearest neighbor interactions, while at low temperatures the situation is reversed, respectively producing a disordered and an ordered state. At the critical point, the tendency for the spins to align is exactly counterbalanced by the disorder caused by the heat. At that stage, you no longer have global order. Instead, there will be local domains where a group of spins are pointed up, and other domains where the spins are pointed down. The sizes of these domains vary widely at this temperature; many are small but a few are quite large. So, this state is an interesting mix of order and disorder, and constantly changing over time (10).

“Through a transition to another more ordered state, the system reduces its free energy. An important ‘law’ is that systems strive to decrease free energy. Systems can reduce their free energy, by introducing order.”

As I explained, there also was (and is) a conflict between order and disorder in the System. During the period 1495–1945, this conflict produced a finite-time singularity in the anarchistic System which was accompanied by four accelerating cycles, and ultimately (in 1939), a phase transition when the anarchistic System reached the critical connectivity threshold.

The principle of ‘least free energy’ also applies to the System and its dynamics. As I explained, the System implemented upgraded orders through systemic wars, to decrease the free energy (tensions) in the System, consistent with the second law of thermodynamics.

A phase transition occurs at the critical point of the system. However, a critical point (criticality) does not by definition imply that the system will experience a phase transition. It has been argued that certain systems create a ‘balance’ at a critical point; a critical point is the attractor of this category of systems (5), (36). During the period of 1495–1945 the System four times reached a critical point. However, it was only through the fourth time that the System experienced a phase transition. After the first three times, the

System 'retracted' from the critical point by resetting its initial conditions and parameters.

"A critical point is used to describe the presence of a very narrow transition domain separating two well-defined phases, which are characterized by distinct macroscopic properties that are ultimately linked to changes in the nature of microscopic interactions among the basic units. The lack of a boundary beyond the critical point makes possible a continuous movement from one phase to the other, provided that we follow the appropriate path; the critical curve (boundary) does not have to be crossed."

The critical point describes a condition where there is in fact no longer a distinction between two phases. Such a condition is reached when the control parameters of the system (in the case of water, temperature and pressure) have specific values. "The presence of this point has a crucial relevance in understanding the nature and dynamics of many natural and social phenomena," according to Solé.

I suggest that the System experienced a second order phase transition, implying that during the phase transition (through the fourth systemic war, the Second World War, 1939-1945) there was in fact no distinction between the anarchistic (implying 'disorder') and non-anarchistic phases (implying 'order'). This lack of a critical boundary at that stage made the continuous movement from an anarchistic phase to a non-anarchistic phase possible. Precisely at the critical point (1939-1945), order (anarchy) and disorder temporarily coexisted. At that point, from an organizational point of view, groups of states in the core of the System and the anarchistic international order merged into two new '(super)structures'; into two dedicated non-anarchistic hierarchies, making state-structures, as well as the anarchistic international order, obsolete.

If we measure the size of clusters (composed of collections of atoms with the same spin direction in the Ising model or, in the context of this study, composed of collections of states engaged in war), we find that the shape of the distribution of cluster sizes is a power law.

Power laws are associated with dynamics close to a critical point and indicate the presence of large fluctuations. Near the critical point, the system displays scale invariance. "If we observe such a system at different spatial scales, it actually looks the same; the system has self-similar characteristics." However, although power laws are hallmarks of criticality, power laws can also be produced by other mechanisms unrelated to criticality.

As discussed, a fundamental change in the behavior of the System was accomplished in a relatively short time span (1939–1945). However, according to Solé, to qualify as a phase transition, it is also necessary that the shape of the distribution of cluster sizes during the phase transition is a power law. In this context 'cluster sizes' refers to the sizes of 'clusters' of states and fighting units that are engaged in war (fighting) during the fourth systemic war (the Second World War). In other words, 'cluster sizes' refers to the sizes of sub-issues, 'sub-wars,' military campaigns, and battles taking place during the fourth systemic war (the Second World War).

The fundamental change in behavior before and after the assumed phase transition (1939–1945) can be proven. I argue that the phase transition – by implementing an upgraded order in the core of the System (initially two dedicated hierarchies that merged into one in 1989) – resulted in a reduction in the free energy the System produced by neutralizing the security dilemma and anarchy within respective hierarchies.

The question now is, to lend credibility to my hypothesis that the System experienced a phase transition during the period 1939-1945, if the shape of the distribution of sub-wars, campaigns and battles during the fourth systemic war (the Second World War) indeed is a power law? I assume it is, but by lack of data this particular property of the System during the fourth systemic war cannot be proven.

Although the existence of a power-law distribution of cluster sizes during the fourth systemic war cannot be proven, other evidence clearly points to the existence of a phase transition in the System (1939–1945). The existence of a finite-time singularity accompanied (i.e., preceded) by four accelerating cycles also supports this hypothesis. My reasoning is as follows. The singularity dynamic started around 1495. Connectivity was the driver (control parameter) of this dynamic. In 1939, the connectivity of the System reached a critical threshold, resulting in a phase transition. The phase transition had two simultaneous closely related effects: integration in Europe (the core of the System) by implementing two dedicated hierarchies, and expansion of the System toward a global scale by implementing the first global order. The fourth systemic war (the Second World War in 1939–1945) constituted the actual phase transition of the anarchistic European System toward two initially dedicated hierarchies. This dedicated hierarchy in Western Europe provided the foundation for the process of economic and political integration that followed, and received an extra boost when the Eastern hierarchy collapsed in 1989. The four cycles that make up the singularity dynamic show remarkable regularities and cohesion, suggesting that the phase transition was an integral part and logical outcome of the finite-time singularity dynamic.

The correlation length of a system is a property that is also associated with phase transitions. The correlation length measures the characteristic distance with which the behavior of one element of the system is correlated with or influenced by the behavior of another element. Its divergence of the correlation length at the critical point implies that two distant points influence each other and are associated with the emergence of very large clusters. Jensen (32) explains the term correlation length as follows: "The nature of the critical state is described by the response of a system to external perturbation. For systems exhibiting noncritical behavior, the reaction of the system is described by a characteristic response time and characteristic length scale over which the perturbation is felt spatially. Although the response of a noncritical system may differ in detail as the system is perturbed at different positions and at different times, the distributions of responses is narrow and well described by the average response. For a critical system, the same perturbation applied at different positions or at the same position at different times can lead to a response of any size. The average may not be a useful measure of the response; in fact, the average might not even exist."

The start of the First World War (the third systemic war, 1914-1918) demonstrates the practical meaning of correlation length. I argue that the System had reached a critical point in June 1914, implying that an issue cluster percolated the System leading to a correlation length of one. The correlation length of one (that spanned the System) enabled a relatively small incident (i.e., the assassination of Archduke Franz Ferdinand in Sarajevo, June 1914) to reverberate ('cascade') in a short time through the entire System, and to trigger the third systemic war (better known as the First World War).

There still is a lot of speculation about why and how such a devastating 'global' war could unexpectedly emerge as a consequence of a relatively small incident. I argue that at the time Archduke Franz Ferdinand was assassinated in 1914, the System had reached a critical condition as a consequence of the buildup of issues, tensions and destructive potential in the preceding decennia. The criticality of the System at that stage explains the System's behavior; criticality implies a correlation length of one and a very high susceptibility to perturbations. Such a correlation length—spanning the system—ensures system-wide communication and coordination.

Watts also explains the (related) typical dynamic that certain systems, just before reaching a critical condition, show 'misleading' (surprising) dynamics (72). Watts observes that certain systems (including the System, I propose), just before showing a massive response in reaction to a small perturbation (trigger), often show remarkable stability. This typical counterintuitive system behavior (stability followed by a systemic response to a perturbation) is what surprised politicians and populations at that moment in time (1914), and still 'misleads' historians today in their efforts to make sense of the unexpected outbreak of the First World War (18).

Thus, it was not this specific incident that initiated the First World War, as is often suggested, but the critical condition of the System that had been in the making since the end of the preceding systemic war in 1815. This implies that, if Archduke Franz Ferdinand had not been murdered in June 1914, another incident would have had a similar devastating (and surprising) non-linaer impact. In other words, another incident would have caused a systemic war that may not have been the First World War as we know it, but would have been another 'version' of this unavoidable critical period. The deterministic nature of the singularity dynamic implies that these systemic wars unfold according to a time-table that is contained in the initial conditions of the System at the inception of singularity dynamic (1495).

Finally, symmetry and symmetry-breaking are phenomena related to phase transitions. Symmetry is an important property of structures and systems. Symmetry and the phenomenon of symmetry breaking are also related to phase transitions. In the case of a phase transition, the symmetry (internal organization) of the system changes. This 'breaking of symmetry' is responsible for the evolution of the complexity of the system. 'Breaking of symmetry' leads to the emergence of new order and a reduction in free energy.

Playing field for contingent dynamics
See: *Latitude for contingent dynamics*.

Poised 'at the edge of chaos'
This concept and terminology is introduced by Kauffman (36). Kauffman's and Bak's (5) concept 'overlap'; in both cases the critical point is assumed to be the attractor of the system in question. Kauffman addresses tow questions (1) Why and (2) how Boolean (binary) systems become 'poised at the edge of chaos'.

1 ***Why do Boolean systems become poised at the edge of chaos?***
With regards to this question, Kauffman observes, "... we turn from a description of behavior in dynamical systems in general and of Boolean networks in particular to the fundamental topic of the capacities of such systems to adapt by mutation and selection. This is the stuff of evolution." "We examine the attractive hypothesis that networks poised at the edge of chaos can perform the most complex tasks. Furthermore, we consider whether selection can achieve such poised systems." If this indeed is the case, Kauffman explains, "... then we may have succeeded in discovering the characteristic kind of complex system which selection achieves in order to optimize both evolvability and fitness."

"All the results (...) indicate that a phase boundary separates networks that exhibit frozen, orderly dynamics from those that exhibit chaotic dynamics. The existence of this boundary leads us to a very general and potentially very important hypothesis: Parallel-processing systems lying in this interface region between order and chaos may be those best able to adapt and evolve." Parallel-processing systems are systems that can perform different tasks simultaneously. The System qualifies as a parallel-processing system since it can (for example) simultaneously balance the specific interests of different and uneven states.

Kauffman elaborates further: "Boolean networks, among the most general class of massively parallel-processing systems, exhibit three broad regimes of behavior. Systems may lie in the ordered regime with frozen components, in the chaotic regime with no frozen components, or in the boundary region between order and chaos where frozen components just melt. The existence of this phase transition suggests that the boundary region might be a particularly interesting region for useful behavior in complex parallel-processing networks. The central idea is that, if a network is deep in the frozen phase, then little computation can occur within it. At best, each small unfrozen, isolated island engages in its own internal dynamics functionally uncoupled from the rest of the system by the frozen component. In the chaotic phase, dynamics are too disordered to be useful. Small changes at any point propagate damage to most other elements in the system. Coordination of ordered change is excessively difficult. At the boundary between order and chaos, the frozen regime is melting and the functionally isolated unfrozen islands are in tenuous shifting contact with one another. It seems plausible that the most complex, most integrated, and most evolvable behavior might occur in this boundary region. It is not yet unambiguously clear that this hypothesis is correct. I describe next supporting reasons and, more important, an approach now under way to investigate whether complex adaptive systems attain the edge of chaos. The preliminary results are encouraging."

"… natural selection may be the force which pulls complex adaptive systems into this boundary region. If so, we begin to have a powerful tool with which to examine the collaborative interaction between self-organization and selection."

Kauffman argues that systems, through selection and self-organization, find a point in the region between order and chaos (i.e., the 'edge of chaos') because, at that point, its performance (fulfillment of its functions) and evolvability (necessary to ensure continued optimal performance when the connectivity and tensions (free energy) levels are changing) are optimized. Optimal evolvability ensures continued optimal performance, which is necessary for survival. These dynamics are closely related to two important principles (related to the second law of thermodynamics) that also apply to the System, namely 'the principle that free energy will put to work' to create new order and 'the principle of least free energy' shapes its design.

2 ***How do Boolean systems become poised at the edge of chaos?***

Kauffman suggests that certain functions of the system at the 'edge of chaos' or a critical point are optimized. "There are grounds to suppose that parallel-processing networks near the boundary of chaos can perform the most complex computations." Kauffman furthermore suggests "natural selection generically seeks and attains systems at the edge of chaos in order to perform complex computations." If such selection induces complex systems to become 'poised at the edge of chaos,' including the System, then the implication is "that nearly universal principles of construction, are applicable to a broad category of dynamical systems." Kauffman observes, "it is eminently plausible that Boolean networks in the ordered regime but near the boundary of chaos may harbor both the capacity to perform the most complex tasks and the capacity to evolve most adequately in a changing world." Moreover, "it seems that genomic systems of plants to animals, separated for the past 600 million years, are all poised near the edge of chaos, then we would virtually have to conclude that selection has achieved such a poised state."

"If true, this finding would provide striking evidence that parallel-processing systems with nearly melted frozen components possess the construction requirements that permit complex systems to adapt. Hence such features might be quasi-universal in complex adaptive systems."

"We have now seen that the transition region between order and chaos gives rise to the most complex dynamics. In addition, tentative evidence supports the hypothesis that parallel-processing systems coevolving to carry out complex tasks do in fact evolve both from the ordered regime and from the chaotic regime toward the edge of chaos." "Such poised systems are also highly evolvable." "Thus we are led to a bold hypothesis: Living systems exist in the solid regime near the edge of chaos, and natural selection (*IP: Kauffman also uses the terminology: adaptive evolution*) achieves and sustains such a poised state."

"If it is the case that systems poised between order and chaos are indeed the natural culmination of selective evolution, we shall have found deep laws indeed. But caution obviously is required about so large an issue. We do not yet know the range of tasks for which systems in the complex regime are the optimal solution. Nor most important, do we know with conviction what biological systems, if any, abide at the edge of chaos. Adaptation to the edge of chaos may ultimately become a general principle in biology. At present, it must be held as a working hypothesis." "Thus we seek overarching principles which may permit and govern the emergence of entities capable of coevolving with one another. Since, we may suppose, selection is critical in this emergence, we must seek to understand the ways in which selection attains systems able to coevolve."

Kauffman also observes, "... we found evidence that parallel-processing, nonlinear, dynamical systems, in particular, Boolean networks, crystallize order. Notably, we found evidence that a phase transition occurs between frozen 'solid' and chaotic 'gas' behaviors. Between these two extremes lies a 'liquid' region with nearly melted frozen components, poised at the edge of chaos. Such systems appear able to carry out the most complex computations and yet may harbor sufficiently ordered fitness landscapes that the systems are able to evolve well." "Quite strikingly, we shall uncover evidence that natural selection, in a selective meta-dynamics, may drive co-evolutionary systems to a 'liquid' state poised on the edge of chaos. At present, it is an attractive hypothesis that complex coevolving systems ultimately tend to a state in which each system internally is poised at the edge of chaos and that all such systems may coevolve to the edge of chaos as an 'ecosystem.'"

It is evident that Kauffman's perspective is (at least to a certain) extent identical to that published by Bak et al. Kauffman observes, in relation to the SOC-research of Bak et al.: "The supposition that selection can act on a co-evolutionary system to control its connectivity, and therefore its dynamics, points in a very interesting direction. It might be the case that coevolving ecosystems tend toward a state of "self-organized criticality" in which parts of the ecosystem are frozen for long periods, such that the species (*IP: Kauffman refers to biological systems*) in the frozen component do not change, while other species continue to coevolve. Avalanches of changes initiated at local points in the ecosystem web may propagate to various extents throughout the ecosystem. Such avalanches may trigger speciation and extinction events. Furthermore, the endogenous dynamics of the coevolving system acted on by selection may tend toward this poised state in which such avalanches can propagate on a variety of size scales with a power-law distribution between sizes of avalanches and their frequencies. Indeed, the theory comes close to predicting the size distribution of extinction events in the evolutionary record."

Population size and growth

During the 1495-1945 period the population of the System continuously grew, and is still growing.

Populations are organized in 'units' - states - to ensure the fulfillment of their basic requirements and survival. Over time populations (states) have become increasingly dependent on each other to fulfill their basic requirements.

Population growth, but also higher life expectancies, and increasing wealth expectations and requirements, determine the connectivity of the System.

Connectivity and security are intrinsically incompatible in anarchistic systems, and result in the production of free energy (tensions).

To periodically adjust the order of the System to its increasing connectivity (larger populations of states) and the tensions-levels this implies – and ensure compliance with the second law of thermodynamics – the anarchistic System periodically upgraded its order, through systemic wars.

Periodic upgrades were accomplished through a finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945): the finite-time singularity enabled population growth in the anarchistic System, while 'at the same time' population growth enabled the undisturbed development and unfolding of the singularity dynamic. Population growth and the singularity dynamic constitute a self-reinforcing (positive feedback) mechanism.

Power flux

The Power flux of the System is measured by the sum of the CINC-indices of Great Powers that make up the System, and shows the changes in the sum of the CINC-indices. This study shows that the power flux is not a reliable predictor for war dynamics.
See also: *CINC-index*.

Powerful-become-more-powerful-effect

A 'powerful-become-more-powerful' mechanism was instrumental in a co-evolutionary process involving states (units of the System) and successive international orders. Through systemic wars, dominant states could ensure that (upgraded) international orders especially supported their interests and positions in the System. These privileges further increased the power and influence of (already) dominant states, they could (again) put to use during the next systemic war, etc.

Power law

Power law scaling has the form: ; the exponent '*b*' reflects general dynamic rules that are at play across the system. is a normalization constant.

Near the critical point (during criticality) many variables of a system can be described by power law functions. Numerous other 'mechanisms' (other than criticality) produce power laws; although power laws are suggestive of criticality, the existence of power laws do not by definition imply criticality (there are other ways to establish criticality in systems).

A feature of power laws is that they show no characteristic scale; a property also referred to as 'scale invariance'. When plotted in log-log coordinates, they produce a straight line; this implies that the data has a fractal structure, is 'self-similar. Self-similarity is a characteristic of fractals. Power law distributions are for that reason also referred to as 'scale-free'. In scale-free networks, the degree distribution – the distribution of the number of connections each node possesses – follows a power law.

For a system to produce scale-free (self-similar) dynamics, that can be described by power-laws, it is *not* necessary that the 'underlying' network necessarily has a scale free structure (10), (42).

Regarding scale invariance Sornette observes: "Right at the critical point, scale invariance holds exactly. It is only broken at either the smallest scale, if there is a minimum unit scale, and/or the largest scale corresponding to the finite system size. In between these two limiting scales, the system is fractal. When not exactly at the critical point, the same description holds true, but only up to a scale, called the correlation length, which now plays the same role as did the finite size of the system at the critical point (63)."

Precursory patterns

The four accelerating cycles that accompanied the finite-time singularity dynamic that unfolded in the anarchistic System during the period 1495-1939, can be considered precursory dynamics, that announced the phase transition the anarchistic System (ultimately) experienced, when it reached the critical connectivity threshold in 1939.

As a consequence of the intrinsic incompatibility between (increasing) connectivity (a function of population size/growth) and security in the anarchistic System, the System produced accelerating amounts of free energy (tensions), that had to be put to work at an accelerating pace, to implement upgraded orders and ensure compliance with the second law of thermodynamics. When in 1939 the anarchistic System reached the critical connectivity threshold (the singularity in finite time) the System produced infinite amounts of free energy. At that point the System collapsed, and in response produced a phase transition to ensure compliance with the second law of thermodynamics.

Following the phase transition (the fourth systemic war, the Second World War, 1939-1945), the (now global) anarchistic System developed a second singularity dynamic. At this point the second singularity dynamic is in the high-connectivity regime of the first relatively stable period. Projected population growth suggests that the second singularity dynamic will also be accompanied by a number of accelerating cycles, that can be considered precursory dynamics of a second (a global) phase transition.

Priming effect of high-connectivity regimes
At a certain point during the life cycle of relatively stable periods (international orders), the System reaches a tipping point; tipping points separate low- and high-connectivity regimes of relatively stable periods. Once the high-connectivity regime is reached increasing connectivity of the System, makes states (the nodes of the network) more stable, and the sizes of non-systemic wars – of non-systemic energy releases – decrease as a consequence.

Instead of being released, free energy (tensions) the anarchistic System produces (at accelerated rates) crystallize in underlying vulnerable issue clusters with fractal structures; the System builds up a 'energy release deficit'. Eventually, when these clusters become connected and percolate the System, the System becomes critical and produces a systemic war. A high-connectivity regime is a precondition for the System to become critical; high-connectivity regimes 'charge' - prime - the System for criticality and systemic war.

Principle of least free energy
All systems, including the System, obey the second law of thermodynamics, which states that all processes occur in order to minimize the overall free energy. I refer to this principle as the 'principle of free energy.'

The System produces free energy (tensions), as a consequence of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems. The principle of least free energy (the second law of thermodynamics) also applies to the free energy (tensions) produced by the System.

Free energy (tensions) in the System is put to work through wars. During systemic wars free energy is put to work to implement upgraded orders that allow for lower energy states of the System.

Privileges of dominant states
Nodes in the network – states in the System – interact on the basis of certain rules. These rules are embedded in international orders and are the outcome of preceding systemic wars in the contingent domain of the System. To ensure the optimal balanced functioning of international orders these (the 'choice' of these) rules must necessarily take into account the different centralities (power positions) of states, that is, their contributions to the overall network's functioning; this means that the rules of the System contain privileges for dominant states. Because of differentiated development of nodes (differen-

tiated growth of states) and the continuously increasing connectivity of the network, rules that apply to the interactions between nodes of the network eventually do not reflect the actual centrality of nodes and undermine the System's functionality. Increasingly obsolete rules and unfounded privileges of certain states contribute to the production of free energy.

Rules that apply to interactions between nodes in the network are only based on a snapshot of the centrality of these nodes during a relatively short critical period (systemic war).
See also: '*Powerful-become-more-powerful effect*'

Punctuated equilibrium dynamic
"Punctuated equilibrium theory makes two contentions: that evolutionary change (or at least very significant proportions thereof) occurs in rapid bursts over short intervals of time, and that there is relative stasis after the punctuational burst" (62).

It can be argued that the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), to a certain extent qualifies as a punctuated equilibrium dynamic. However, this perspective is not in all respects exact: significant evolutionary change also takes place during relatively stable periods. Great Power status dynamics typically take place during relatively stable periods, and are then during punctuations (systemic wars) embedded in the upgraded order of the System.

Relatively stable periods and periods of criticality (systemic wars) are inseparably linked: during high-connectivity regimes of relatively stable periods the System is charged for a next systemic war.

Regimes
In this study I use the term 'regime' in two different meanings (contexts). Two 'categories' of 'regimes' can be distinguished: (1) low- and high-connectivity regimes as defined by Watts (72), when regime refers to fundamentally different 'mechanisms' that determine the properties (size and frequency) of cascade dynamics, and (2) regimes as defined by Kauffman (36).

The term 'regime' in Kauffman's framework does not refer to low- and high-connectivity regimes that can be distinguished during relatively stable periods (international orders) of successive cycles of the finite-time singularity dynamic. Kauffman distinguishes between three types of regimes: a disordered or chaotic regime, a complex or transition regime, and an ordered regime. The complex (transition) regime separates the other two regimes. Kauffman also refers to the complex (transition) regime as 'the edge of chaos,' which in fact is the critical point of the system. Kauffman argues that, when a system is poised 'at the edge of chaos' (in other words, at the critical point, in the complex and transit regime) certain functions, including the system's evolvability, are optimized.
See also: *Low connectivity regime*, *High connectivity regime*, and *Regimes of behavior of Boolean networks*.

Regimes of behavior of Boolean networks
"… NK Boolean networks permit us to study the emergence of order in systems coordinating the activities of thousands or even billions of elements. In NK Boolean networks, each element has two possible states of activity: active or inactive; a network links the activity of each of its N elements to the prior activities of K other elements. Random Boolean networks are a vast family of disordered systems" (36).

Kauffman discusses three regimes of behavior random Boolean networks can exhibit, and how a network adapts depending on its regime. According to Kauffman random Boolean networks exhibit three broad regimes of behavior: ordered, chaotic and complex.

1 ***Ordered regime.***
"In the ordered regime, many elements in the system freeze in fixed states of activity. These frozen elements form a large connected cluster, or frozen component, which spans, or percolates, across the system and leaves behind isolated islands of unfrozen elements whose activities fluctuate in complex ways.

2 ***Chaotic regime.***
In the chaotic regime, "there is no frozen component. Instead, a connected cluster of unfrozen elements, free to fluctuate in activities, percolates across the system, leaving behind isolated frozen islands. In this chaotic regime, small changes in initial conditions unleash avalanches of changes, which propagate to many other unfrozen elements. These avalanches demonstrate that, in the chaotic regime, the dynamics are very sensitive to initial conditions. The transition from the ordered regime to the chaotic regime constitutes a phase transition, which occurs as a variety of parameters are changed."

3 ***Complex (or transition) regime.***
The transition region, on the edge between order and chaos, is the complex regime. "Here (*IP: in the complex regime*) the frozen component is just percolating and the unfrozen component just ceasing to percolate, hence breaking up into isolated islands. In this transition region, altering the activity of single unfrozen elements unleashes avalanches of change with a characteristic size distribution having many small and few large avalanches." Kauffman observes: "The transition from chaos to order in random Boolean networks occurs either as K decreases to 2 or as other parameters are altered in simple ways". This observation is consistent with my observation that non-systemic war dynamics are chaotic when the number of degrees of freedom of the System is more than two (n > 2).

Relatively stable period
The first finite-time singularity dynamic (1495-1945) was accompanied by

four accelerating cycles; the second singularity dynamic (1945-...) presently is in its first cycle.

Cycles typically consist of relatively stable periods, followed by a critical period; that is systemic war. During relatively stable periods, the anarchistic System produces non-systemic wars. Relatively stable periods are also referred to as 'international orders' and vice versa.

Release event
See: *Non-systemic release event* and *Systemic release event*.

Release ratio
The release ratio of a cycle is: The severity of the systemic war of the cycle divided by the total severity of all wars during the cycle. During the unfolding of the first finite-time singularity (1495-1945) the release ratio increased very regularly (except for a distortion during the second cycle (1648-1815)), indicative for a fundamental change in the energy release distribution of energy during successive cycles.
See also: Energy release distribution (during cycles).

Representativeness
The extent in which organizational arrangements that underpin international orders reflect the actual power and influence of states in the System, determines the representativeness of international orders.

During systemic wars actual power and influence of states is (re-)aligned with organizational arrangements that underpin international orders. It is a matter of time before international orders become obsolete (dysfunctional); not only because states gain or lose power and influence relative to each other (changes that are not reflected in the international order), but also because international orders have to cope with increasing levels/amounts of free energy (tensions) the increasingly connected anarchistic System unavoidably produces: more free energy/tensions requires higher levels of organizational integration.

Robust(ness)
Robustness concerns a property of relatively stable periods of the anarchistic System. The robustness of the anarchistic Systems is its ability to 'absorb' perturbations without producing non-systemic wars. The absolute number of non-systemic wars during relatively stable periods, and the war-frequency of relatively stable periods are measures for its robustness. I assume that the robustness of the System (relatively stable periods) is a function of its connectivity.

During the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945), the number of wars during successive relatively stable periods and the war frequency decreased linearly, implying that the System's robustness increased linearly.

During the fourth relatively stable period (1918-1939) the robustness became 'absolute'; the System no longer produced (was able to produce) non-systemic wars. At that point the System also had become 'infinite' fragile: robustness and fragility of the System are two sides of the same coin. Absolute robustness implies a release ratio of 'one'.

Robust yet fragile
During the unfolding of the finite time singularity dynamic accompanied by four accelerating cycles (1495-1945) the System became more robust and fragile at the same time. Robustness and fragility are deterministic properties of the System. The concept of 'robust, but fragile' describes the paradoxical behavior of certain systems that, on the one hand, become more effective in reacting to certain perturbations (i.e., more robust) but, on the other hand, simultaneously become more fragile regarding their ability to maintain themselves within a certain 'stability domain' (i.e., accompanied by a certain mode of behavior). Increasing robustness and increasing fragility in the System go hand in hand. They are closely related, interacting properties that are in fact two sides of the same coin: increased robustness contributes to and fuels increased fragility. Watts (72) observes that cascades "can be regarded as a specific manifestation of the robust yet fragile nature of many complex systems: a system may appear stable for long periods of time and withstand many external shocks (*IP: indicative for its robustness*), then suddenly and apparently inexplicably exhibit a large cascade (*IP: indicative for its fragility*)."
See also: *Cascade dynamics, cascades triggered by shocks*

Scale invariance
See: *Power law.*

Scaling up and scaling down
Scaling up and scaling down are two dimensions of a trend of successive (systemic) wars becoming more total. 'Scaling up' refers to the phenomenon that states leverage increasing capabilities and resources – and ultimately their 'total' societies – to maximize the deployment of destructive energy; 'scaling down' refers to the increasing empowerment of communities and individuals to contribute to, or fight their own, wars.

Scaling up occurred during the unfolding of the first finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945); following the dual phase transition (1939-1945), a process of scaling down can be observed.

Scaling down means that communities and individuals increasingly fight their 'own' wars. A trend can be observed towards hybrid/community-warfare.

second law of thermodynamics
With the term 'second law of thermodynamics', I refer to the phenomenon

that free energy (tensions in the anarchistic System) will be put to work, to implement upgraded orders, that allow for lower energy states of the System.

In anarchistic systems free energy is produced as a consequence of the intrinsic incompatibility between connectivity and security.

Security community

Deutsch defines a security community as "a group of people 'believing' that they have come to agreement on at least this point: that common social problems must and can be resolved by processes of peaceful change." (22).

A security community has the potential to reorganize itself and adapt to change, without resorting to violence. This peaceful dynamic is made possible by the collective acceptance of a set of values that do not allow violence as a legitimate form of behavior between states that constitute the community.

Security dilemma

The security dilemma is an intrinsic property of anarchistic systems. In anarchistic systems states are responsible for their own security. The dilemma is that one state's security is another state's insecurity.

Because of the intrinsic incompatibility of (increasing) connectivity and security in anarchistic systems, anarchistic systems produce free energy (tensions). The security dilemma constitutes a self-reinforcing (positive feedback mechanism): if state A (preventively) deploys destructive energy because of a perceived threat by state B, state B will probably take certain precautions in response; the response of state B will be interpreted by state A as a confirmation of state B's aggressive behavior towards state, etc. The security dilemma also works as a self-fulfilling prophecy.

The security dilemma and interacting self-fulfilling prophecies constitute the interface between the deterministic and contingent domain of the System. See also: *Interface* and *Interacting self-fulfilling prophecies*.

Security-interdependence

During the development and unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles during the 1495-1945 period, states and their populations became increasingly dependent on each other for the fulfillment of their basic requirements, and to ensure their (collective) survival.

Connectivity growth (caused by population growth) was (and still is) the driver of the finite-time singularity dynamic; connectivity growth in anarchistic systems leads to the production of free energy (tensions), as a consequence of the intrinsic incompatibility between connectivity and security in these type of systems. Through connectivity (that is population) growth the finite-time singularity was supplied with enough energy to ensure its development and unfolding.

The paradox in anarchistic systems is, that connectivity – and the (upgraded) orders that are implemented over time – on the one hand contribute to the fulfillment of basic requirements of states and their populations, but on the other hand, 'at the same time', contribute to their insecurity.

Increased connectivity and interdependence of states also includes their mutual security. Connectivity in anarchistic systems comes at a price: insecurity.

Self-organization

Self-organization describes "the ability by certain non-equilibrium systems to develop structures and patterns in the absence of control or manipulation by an external agent" (32).

Self-organized criticality

To develop the theory of SOC-systems, Bak extensively researched sand piles, and avalanches that can be observed when sand is added to the pile. Avalanches are so-called 'release events,' defined as events by which a system releases energy that has built up in the system. 'Wars' can also be considered release events. Despite the fact that the System does not qualify as an SOC system (as I explain later), Bak's research is useful: It 'forces' us to address certain questions regarding the dynamics of the System, and by doing so provides us with valuable insights.

Bak et al. (3) suggests that "a general organizing principle governs a class of dissipative coupled systems" that "evolve naturally toward a critical state, with no intrinsic time or length scale." A critical point is assumed to be the attractor of this category of systems. By 'self-organized,' Bak means that the "system naturally evolves to a critical state without detailed specification of the initial conditions, i.e. the critical state is an attractor of the dynamics." According to Bak, the hallmark of SOC is its lack of any scale in time as well as in space (32). This is typical of any system at its critical point.

A number of systems – including the brain – seem to self-organize toward criticality (10). At the critical point these systems can optimize certain functions by 'using' its correlation length of one (at that point) that enables for system-wide communication, coordination and computation.

Although the System has certain SOC-characteristics, the System does not qualify as a SOC-system: the critical point of the System is not its attractor.

In the research article "Self-organized criticality", Bak et al. (3) describe the basic idea of SOC as follows: "To illustrate the basic idea of self-organized criticality in a transport system, consider a simple 'pile of sand.' Suppose we start from scratch and build the pile by randomly adding sand, a grain at a time. The pile will grow, and the slope will increase. Eventually, the slope will reach a critical value; if more sand is added it will slide off. Alternatively, if we start from a situation where the pile is too steep, the pile will collapse until it reaches the critical state, such that it is just barely stable with respect to further perturbations. The critical state is an attractor for the dynamics. The quantity which exhibits 1/f noise is simply the flow of sand falling off the pile." This and other models "evolve into a critical state: as the pile is built up, the characteristic size of the largest avalanches grows, until at the critical point there are avalanches of all sizes up to the size of the system, analogous to the domain distribution of a magnetic system at a phase transition.

The energy is dissipated at all length scales. Once the critical point is reached, the system stays there. The behavior of systems at the self-organized critical point is characterized by a number of critical exponents – which are connected by scaling relations – and the systems obey 'finite-size scaling' just as equilibrium systems at the critical point."

Bak argues that SOC is a general organizing principle that applies to a large category of systems: "I will argue that complex behavior in nature reflects the tendency of large systems with many components to evolve into a poised, 'critical' state, way out of balance, where minor disturbances may lead to events, called avalanches, of all sizes (5). Most of the changes take place through catastrophic events rather than by following a smooth gradual path. The evolution to this very delicate state occurs without design from any outside agent. The state is established solely because of the dynamical interactions among individual elements of the system: the critical state is self-organized."

Bak further argues (5) that SOC occurs and can only occur in non-equilibrium systems, producing a 'punctuated equilibrium dynamic' in which relatively long periods of stasis characterized by gradual development are punctuated by short intervals during which the system shows bursts of activity and volatility that result in more significant development/evolution: "In general, systems in balance do not exhibit any of the interesting behavior discussed above, such as large catastrophes, 1/f noise, and fractals. In the equilibrium state, small perturbations or shocks will cause only small disturbances, modifying the equilibrium state only slightly. The system's response is proportional to the size of the impact; equilibrium systems are said to be 'linear'. Contingency is irrelevant. Small freak events can never have dramatic consequences. Large fluctuations in equilibrium systems can occur only if many random events accidentally pull in the same direction, which is prohibitively unlikely. Therefore, equilibrium theory does not explain much of what is actually going on, such as why stock prices fluctuate the way they do. Systems in balance or equilibrium, by definition, do not go anywhere."

"As pointed out by Gould and Eldridge, the apparent equilibrium is only a period of tranquility, or stasis, between intermittent bursts of activity and volatility in which many species become extinct and new ones emerge. Also, the rate of evolution of individual species, as measured, for instance, by their change in size, takes place episodically in spurts. This phenomenon is called punctuated equilibrium. The concept of punctuated equilibrium turns out to be at the heart of the dynamics of complex systems. Large intermittent bursts have no place in equilibrium systems, but are ubiquitous in history, biology, and economics. None of the phenomena described above can be explained within an equilibrium picture. On the other hand, no general theory for large non-equilibrium systems exists."

According to Bak SOC-systems self-organize to a critical condition without outside tuning. Bak explains how a model system consisting of pendulums reaches a critical condition without tuning the control parameter of the system (5). At the critical point, "there were avalanches of all sizes just as there were clusters of all sizes at the critical point for equilibrium phase transitions. But no tuning was involved. (...) There is no temperature to regulate, no λparameter to change. The simple behavior of the individual elements following their own simple local rules had conspired to create a unique, delicately balanced, poised, global situation in which the motion of any given element might affect any other element in the system. (...) The system had self-organized into the critical point without any external organizing force. Self-organized criticality (SOC) had been discovered. It was as if some 'invisible hand' had regulated the collection of pendulums precisely to the point where avalanches of all sizes could occur. The pendulums could communicate throughout the system. Once the poised state has been reached, the 'criticality' is similar to that of a nuclear chain reaction. Suppose you have a collection of radioactive atoms emitting neutrons. Other atoms, causing them to emit neutrons of their own, might absorb some of those neutrons. A single neutron leads to an avalanche. If the concentration of fissionable atoms is low, the chain reaction will die out very soon. If the concentration is high, there will be a nuclear explosion similar to that in an atomic bomb. At a unique critical concentration there will be avalanches of all sizes, all of which will eventually stop. Again, one has to 'tune' nuclear chain reaction by choosing precisely the correct amount of radioactive material to make it critical. In nuclear reactors this tuning is very important and is carried out by inserting neutron-absorbing graphite rods. In general, the reactor is not critical. There is absolutely no self-organization involved in a nuclear chain reaction, so in this all- important aspect the situation is entirely different."

I argue that during the period of 1495–1945, the System attained four times a critical point, also without outside tuning. The System was pushed into criticality by a combination of conditions, including population and connectivity growth and rivalry between states. Although this behavior is in some respects similar to the behavior of self-organized criticality in Bak's sand pile, the System does not qualify as an SOC system. Although the System reached a critical point four times, a critical point is not the attractor of the System, but merely a 'step' in a process (the singularity dynamic) that ultimately results in a phase transition. Because systemic war represents criticality in the System, states and the System would self-destruct if the system reaches a 'stationary state,' a type of equilibrium, at a critical point: systemic war can for a number of reasons not be sustained for longer intervals of time because of the 'energy' that is required and the destruction systemic wars cause. For the System, criticality is only an intermittent instrumental condition, not a viable and useful end condition that serves the purposes of the Systems and its constituents.

Bak also points to the importance of energy build ups and transfers in a system; such a perspective also is very useful to better understand the dynamics and the development of the System.

In his study, Bak described the process of energy transfer in the sand pile: "An open dissipative system had naturally organized itself into a critical scale-free state with avalanches of all sizes and all durations (5). The statistics of the avalanches follow the Gutenberg-Richter power law. There were small events and large events following the same laws. We had discovered a simple model for complexity in nature. The variability that we observe around us *(IP: Bak refers to avalanches of different sizes, and their distribution, produced by SOC)* might reflect parts of a universe operating at the self-organized critical state. While there had been indications for some time that complexity was associated with criticality, no robust mechanism for achieving the critical state had been proposed, nor had one been demonstrated by actual calculation on a real mathematical model."

"But before discussing the mathematical formulation of our model, let us recall the sandpile experiment." "Consider a flat table, onto which sand is added slowly, one grain at a time. The grains might be added at random positions, or they may be added only at one point, for instance at the center of the table. The flat state represents the general equilibrium state; this state has the lowest energy, since obviously we would have to add energy to rearrange the sand to form heaps of any shape.

"Initially, the grains of sand will stay more or less where they land. As we continue to add more sand, the pile becomes steeper, and small sand slides or avalanches occur. The grain may land on top of other grains and topple to a lower level. This may in turn cause other grains to topple. The addition of a single grain of sand can cause a local disturbance, but nothing dramatic happens to the pile. In particular, events in one part of the pile do not affect sand grains in more distant parts of the pile. There is no global communication within the pile at this stage, just many individual grains of sand. As the slope increases *(IP: equivalent with the connectivity of the issue network of the System, that develops over time)*, a single grain is more likely to cause other grains to topple. Eventually the slope reaches a certain value and cannot increase any further, because the amount of sand added is balanced on average by the amount of sand leaving the pile by falling off the edges. This is called a stationary state, since the average amount of sand and the average slope are constant in time.

"It is clear that to have this average balance between the sand added to the pile, say, in the center, and the sand leaving along the edges, there must be communication throughout the entire system. There will occasionally be avalanches that span the whole pile. This is the self-organized critical (SOC) state. The addition of grains of sand has transformed the system from a state in which the individual grains follow their own local dynamics to a critical state where the emergent dynamics are global. In the stationary SOC state, there is one complex system, the sandpile, with its own emergent dynamics. The emergence of the sandpile could not have been anticipated from the properties of the individual grains. The sandpile is an open dynamical system, since sand is added from outside. It has many degrees of freedom, or grains of sand. A grain of sand landing on the pile represents potential energy, measured as the height of the grain above the table."

"When the grain topples, this energy is transformed into kinetic energy. When the toppling grain comes to rest, the kinetic energy is dissipated, that is, transformed into heat in the pile. There is an energy flow through the system. The critical state can be maintained only because of energy in the form of new sand being supplied from the outside. The critical state must be robust with respect to modifications. This is of crucial importance for the concept of self-organized criticality to have any chance of describing the real world; in fact, this is the whole idea. Suppose that after the same system has reached its critical stationary state we suddenly start dropping wet sand instead of dry sand. Wet sand has greater friction than dry sand. Therefore, for a while the avalanches would be smaller and local. Less material will leave the system since the small avalanches cannot reach the edge of the table. The pile becomes steeper. This, in turn, will cause the avalanches to grow, on average. Eventually we will be back to the critical state with system-wide avalanches. The slope at this state will be higher than the original ones. Similarly, if we dry the sand, the pile will sink to a more shallow shape by temporarily shedding larger avalanches. If we try to prevent avalanches by putting local barriers, 'snow' screens, here and there, this would have a similar effect: for a while the avalanches will be smaller, but eventually the slope will become steep enough to overcome the barriers, by forcing more sand to flow somewhere else. The physical appearance of the pile changes, but the dynamics remain critical. The pile bounces back to a critical state when we try to force it away from the critical state."

Bak observed that initially the avalanche size increases until the critical point is reached and the sand pile at that stage produces avalanches of all sizes. The size distribution of avalanches at that critical point can best be described with a power law. Avalanches are like wars in that they can be considered release events of energy. The avalanche dynamics can be considered as energy 'transfers' in the sand pile.

In the case of sand piles, as Bak explained, every grain of sand adds energy to this dynamic system, making 'sand' the driver of the dynamics.

I argue that connectivity growth, along with the tensions and buildup of destructive energy it produces, is the driver of anarchistic systems. Destructive energy represents free energy in the System that will, by obeying the 'principle of least energy,' at a certain moment (during systemic wars) be put to work to create new order. In the System, two types of release events (e.g., wars) can be distinguished: systemic and non-systemic wars that have a fundamentally different function in the System. Systemic wars are a manifestation of criticality of the System, are system-wide events and instrumental in implementing new system-wide order. Non-systemic wars, on the other hand, are local events with only local effects that do not allow for system-wide communication, coordination, and planning (as is typically the case in case of criticality). Systemic wars are not scaled-up (i.e., exceptionally large) non-systemic wars; they are a class of their own.

Whereas systemic wars are closely associated with criticality—in fact, they are a manifestation of criticality—non-systemic wars are not directly related to criticality despite the fact that their remarkable size distribution can also best be described with a power law. Non-systemic wars are release events that precede criticality (systemic war). The fact the size distribution of non-systemic wars can be best described by a power law—as I will explain later— can be attributed to the chaotic and periodic properties of this category of wars.

Bak also states (5): “The toppling depends on how the individual grains lock together. Once a grain is falling, its motion is determined by the gravity field, which accelerates the grain, and the interaction with other grains, which tends to decelerate the motion. Stopping the motion depends on many factors, such as the shape of the grains it bumps into and its velocity at that point, and not just the height or slope of the pile at the neighbor points. As the process continues, it becomes more likely that at least one of the neighbors will reach its critical height, so the first toppling event induces a second event. One toppling event leads to the next, like falling dominos. As more sand is added, there will be bigger and bigger landslides, or avalanches, although there will still also be small ones. Eventually the entire sandpile enters into a stationary state where the average height of all sites does not increase further.”

The ‘toppling’ of grains that Bak discussed can produce avalanches. In the case of the System, ‘cascades’ is a more suitable term. Wars can be considered cascades. In this study, I introduce a cascade-perspective (72) to further study the war dynamics of the System. Whereas with Bak’s sand pile topplings (release events) depend on how individual grains are locked together, in the case of wars, the structure of the issue network determines how cascades (topplings) will and can evolve. Cascades are produced by so-called ‘issue clusters’: clusters of issues (and states that are an integral part of these issues) that ‘collectively’ switch to war as the preferred course of action; depending on the structure of the issue network the System produces a war -(a cascade) of a certain size. Based on the model described by Watts, I argue that the size and frequency of non-systemic wars are determined by the connectivity and structure of the network of states and issues, as well as by ‘thresholds’ that states use to determine when they switch to positive war decisions.

Furthermore, “The pile has organized itself into a highly orchestrated, susceptible state through the process of repeatedly adding sand and having avalanches travel through the pile again and again.”

“The power law indicates that the stationary state is critical. We conclude that the pile has self-organized into a critical state. One can show, by analyzing the geometry of the sandpile, that the profile of the sandpile is a fractal, like Norway’s coast.”

"The power law also indicates that the distribution of avalanches follows Zipf's law. Instead of plotting how many avalanches there are of each size, we could equally well plot how large the biggest avalanche was (the avalanche of "rank" one), how large the second biggest avalanche, of rank two was, how large the tenth biggest avalanche was, and so on, precisely the same way that Zipf plotted the ranking of cities. This is just another way of representing the information from the original power law. The straight line shows that the sandpile dynamics obey Zipf's law."

"We had to check that the criticality is robust with respect to modifications of the model. (...) One might speculate that the criticality is caused by the randomness of the way that the system is driven; we add new grains at random positions. In fact, this is not important at all. We can drive the system in a deterministic way with no randomness whatsoever, with all information about the system at all times encoded in the initial condition (...)."

"Since the whole history of the pile in this case was contained in the initial condition, the phenomenon of SOC is essentially a deterministic phenomenon, just like the chaos studied by Feigenbaum. The fact that the randomness of adding sand does not affect the power law indicates that the randomness is irrelevant for the complex behavior we are observing. This fact is important to realize when studying much more complicated systems. Economics deals with the more or less random behavior of many agents, whose minds were certainly not made up at the beginning of history. Nevertheless, this randomness does not preclude the system's evolving to the delicate critical state, with well-defined statistical properties. This is a fascinating point that is difficult to grasp. How can a system evolve to an organized state despite all the obvious randomness in the real world? How can the particular configuration be contingent on minor details, but the criticality totally robust?"

Self-fulfilling prophecy

A self-fulfilling prophecy is a prediction that directly or indirectly causes itself to become true, by the very terms of the prophecy itself, due to positive feedback between the belief and behavior.

Self-organization

Self-organization describes the ability by certain non-equilibrium systems to develop structures and patterns in the absence of control or manipulation by an external agent (32).

The finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) is a self-organized dynamic. The self-organized finite-time singularity dynamic, is a product of just a number of 'simple' conditions/factors, including:

1) The fact that anarchistic systems are intrinsically incompatible and as a consequence produce free energy;
2) Physical laws apply to the free energy the System produces;

3) War decisions qualify as binary decisions with externalities and thresholds;
4) States form networks of binary (war) decisions.

In case of the anarchistic System, states collectively and (until now) unknowingly produced a highly deterministic singularity dynamic, that then 'forced' itself on states and populations in the System, and further shaped their interactions. The interactions between states, and the self-organized structures and dynamics this resulted in, produced a self-reinforcing and increasingly path dependent dynamic towards increasingly severe systemic wars, and increasingly integrated international orders.

Severity

Severity of a war is defined as the number of battle-connected deaths of military personnel (38) of Great Powers that participate in the war. I consider the severity of wars a measure for the 'amount' of destructive energy that is deployed during these wars, and free energy that was produced by the System.

The unit of severity is 'BCD': the number of Battle Connected Deaths of military personnel.

Singularity dynamic

Explanation of the term and concept of singularities and singularity dynamics is based on research and theory developed by Sornette. For example, his research related to financial crashes (63).

Despite some obvious differences between crashes in financial markets and 'crashes' (systemic wars) in the System, at a more abstract level, some interesting similarities can be observed between both systems and their dynamics. Sornette identified finite-time singularities and associated dynamics in financial markets. I argue that similar dynamics—to be more precise, a finite-time singularity dynamic accompanied by four accelerating cycles—can be observed in the war dynamics of the System. When in 1939 the System reached the critical connectivity threshold the anarchistic System collapsed and experienced a phase transition. Through this phase transition dedicated hierarchies were introduced in Western and Eastern Europe that were respectively controlled by the United States and the Soviet Union. 'In' respective hierarchies the security dilemma was neutralized resulting is a (temporary) decrease in free energy in the System.

Sornette argues, "uncertainties and variability's are the key words to describe the ever-changing environment around us. Stasis and equilibrium are illusions, whereas dynamics and out-of-equilibrium are the rule. The quest for balance and constancy will always be unsuccessful." Moreover, Sornette emphasized that "the essential importance of recognizing the organizing/disorganizing role of extreme events, such as momentous financial crashes" and "recognizes that sudden transitions from a quiescent state to a crisis or catastrophic event provide the most dramatic fingerprints of the system dynamics." As I explained in the previous sections, similar conditions are present in the System, which is to a certain degree 'out-of-equilibrium' and 'defined' by systemic wars that are comparable to extreme events such as the financial crashes that Sornette discussed. These systemic wars are instrumental in implementing upgraded orders (organizing principles, rule sets, etc.) in the System, ensuring its performance; its ability to ensure the balanced fulfillment of basic requirements of uneven states in an anarchistic system.

Sornette "explores the concept that a crash has fundamentally an endogenous, or internal, origin and that exogenous, or external, shocks only serve as triggering factors. As a consequence, the origin of crashes is much more subtle than often thought, as it is constructed progressively by the market as a whole, as a self-organizing process. In this sense, the true cause of a crash could be termed a systemic instability."

Sornette's perspective, assuming that crashes in financial markets fundamentally have an endogenous origin, is similar to that of (for example) Bak in relation to SOC-systems (e.g., avalanches in sand piles) (5). I also argue that this is the case for the war dynamics of the System: wars are also 'constructed progressively' by the System as a whole, as a self-organizing process.

Sornette also observes, "Financial markets are not the only systems with extreme events. Financial markets constitute one among many other systems exhibiting a complex organization and dynamics with similar behavior. Systems with a large number of mutually interacting parts often open to their environment, self-organize their internal structure and their dynamics with novel and sometimes surprising macroscopic ("emergent") properties."

According to Sornette, a central property of complex systems is "the possible occurrence of coherent large-scale collective behaviors with a very rich structure, resulting from the repeated nonlinear interactions among its constituents: the whole turns out to be much more than the sum of its parts." From a somewhat different perspective, Sornette also observed that, in complex systems, relatively stable periods are at certain moments punctuated by extreme events (e.g., financial market crashes and systemic wars in the case of the System) with a relatively short duration that defines the system's future behavior: "It turns out that most complex systems in natural and social sciences do exhibit rare and sudden transitions that occur over time intervals that are short compared to the characteristic time scales of their posterior evolution. Such extreme events express more than anything else the underlying 'forces' usually hidden by almost perfect balance and thus provide the potential for a better scientific understanding of complex systems." "It is essential to realize that the long-term behavior of these complex systems is often controlled in large part by these rare catastrophic events." I argue that this is also the case for the System.

"The outstanding scientific question is thus how such large-scale patterns of catastrophic nature might evolve from a series of interactions on the smallest and increasingly larger scales." More specifically, by applying this question to the dynamics of the System: 'How a finite-time singularity dynamic accompanied by four accelerating cycles evolved from a series of interactions between states, (ultimately) leading to a collapse of the system and a phase transition to a fundamentally different system.'

Building on these insights, it is Sornette's hypothesis "that stock market crashes are caused by the slow buildup of long-range correlations leading to a global cooperative behavior of the market and eventually ending in a collapse in a short, critical time interval. The use of the word 'critical' is not purely literary here: in mathematical terms, complex dynamical systems can go through so-called critical points, defined as the explosion to infinity of a normally well-behaved quantity. As a matter of fact, as far as nonlinear dynamical systems go, the existence of critical points is more the rule than the exception."

Notwithstanding the drastic differences in epochs and contexts, Sornette shows "that these financial crashes share a common underlying background as well as structure. The rationale for this rather surprising result is probably rooted in the fact that humans are endowed with basically the same emotional and rational qualities in the twenty-first century as they were in the seventeenth century (or at any other epoch)."

A similar observation that I will discuss in more detail in part II and III, can be made regarding war decisions during (at least) the period of 1495-1945: despite fundamental differences in the political organization of states and available technology, war decisions by states and their predecessors (e.g., how they are made, what is considered, etc.) have not fundamentally changed over time. The consistency and regularity of the singularity dynamic supports this hypothesis, as I will explain later.

Sornette also points to the fundamental difference between large crashes and 'normal' crashes. Sornette provides "... strong evidence that large crashes are in fact in a league of their own; they are "outliers." "This realization will call for new explanations and hence may suggest a possibility of predictability." As I explained previously, this is also the case for systemic wars, they are not scaled-up non-systemic wars. Systemic wars are in a class of their own. They are highly predictable, have a system-wide impact, and define the next order and the long-term development of the System. Systemic wars cannot be seen as scaled-up versions of non-systemic wars since these two categories of war (systemic and non-systemic) are produced by two fundamentally different (but related and interacting) mechanisms/dynamics. I argue, similar to Sornette with regards to stock market crashes, that systemic wars are caused by the slow buildup of long-range correlations (between issues, states, and the tensions this creates), leading to global cooperative behavior between states and synchronization of positive war decisions.

Making use of Levy's dataset (38), I identified four so-called systemic wars. All other wars I define as non-systemic wars. In table 4 I present the four systemic wars and some of their properties. The special impact of these four wars and, in some cases also other wars, is also recognized by most historians, who observed their large size, the number of casualties they produced, and the impact they had on the System.

Size of wars

The size of wars can be measured in different ways, including in terms of intensity, severity, extent (the absolute number of Great Powers participating) and fraction.

This study shows that fraction is a very useful measure to assess the condition of the anarchistic System, and the stage of development of cycles.

Fraction is defined as the number of Great Powers participating in a war divided by the total number of Great Powers in the System; it is a relative measure.

See also: *Fraction* and *Intensity*

Slowly driven, interaction-dominated threshold systems

In the study entitled "*Self-Organized Criticality, Emergent Complex Behavior in Physical and Biological Systems*" (32), Jensen clarifies what SOC is and the typical conditions under which SOC arises in different systems. In the following citations, Jensen reflects on SOC and the claims Bak makes.

The term self-organized criticality consists of two elements: 'self-organization' and 'criticality'. Self-organization describes "the ability by certain non-equilibrium systems to develop structures and patterns in the absence of control or manipulation by an external agent." "The word criticality has a very precise meaning in equilibrium thermodynamics: It is used in connection with phase transitions" (see also the previous sections). At a specific transition value of the control parameter, a local distortion of the system not only influences the local neighborhood, but also propagates throughout the entire system. "The system becomes critical in the sense that all members of the system influence each other."

For systems to evolve into an SOC dynamic state, a number of conditions must be met, including the separation of time scales: "The process connected with the external driving of the system needs to be much slower than the internal relaxation processes." "The separation of time scales is intimately connected with the existence of thresholds and metastability. It is the existence of a threshold that ensures the separation of time scales." "One finds, as anticipated, that the distribution functions describing the frequency with which various events occur in the SOC state exhibit power laws." "In fact, SOC combines a number of concepts: self-organization, criticality and complexity." "Phenomena in very diverse fields of science have been claimed to exhibit SOC behavior."

Complexity and network science show that a wide category of dynamical systems consisting of many interacting constituents may exhibit some general characteristic behavior. For instance, they organize themselves into a state with a complex but general structure. "The systems are complex in the sense that no single characteristic event size exists: there is not just one-time and one length scale that controls the temporal evolution of these systems. Although the dynamical response of the system is complex, the simplifying aspect is that simple power laws describe the statistical properties. Moreover, some of the exponents may be identical for systems that appear to be different from a microscopic perspective.

"The claim made by Bak et al. was that this typical behavior develops without any significant 'tuning' of the system from the outside. Further, the states into which systems organize themselves have the same kind of properties exhibited by equilibrium systems at the critical point. Therefore, Bak et al. described the behavior of these systems as self-organized criticality (SOC)." "If a system exhibits power laws without any apparent tuning then it is said to exhibit self-organized criticality; SOC is a phenomenological definition rather than a constructive one."

According to Jensen, SOC behavior is to be expected in "slowly driven, interaction-dominated threshold systems." "The notion of an "interaction-dominated threshold system" focuses on the unique features of such systems: the interesting behavior arises because many degrees of freedom are interacting; and the dynamics of the system must be dominated by the mutual interaction between these degrees of freedom." The effect of the threshold is "to allow a large number of static metastable configurations." The local stabilizing effect is also called 'local rigidity.' Jensen argues that "the existence of local threshold is a necessary, although certainly not sufficient condition for self-organizing to criticality." The 'driving' of the system needs to be slow because "a strong drive will not allow the system to relax from one metastable configuration to the other. The slow drive is needed in order for the intrinsic properties of the system to control the dynamics." There must be time for the system "to relax in the equilibrium configurations." If the external drive is too fast, "the behavior of the system will be completely dominated by the external applied drive." In fact, the strong drive will then neutralize the effect of the threshold, which is needed for SOC behavior to emerge.

Social collapse
See: *Social fragmentation*.

Social fragmentation
Social fragmentation (social collapse, fragmentation) is the opposite of social integration and expansion, and implies the disintegration of (integrative) structures.

In case of SIE as well as social fragmentation, reinforcing (positive feedback) loops dominate the System's dynamics.

A change of a non-anarchistic social system (a state or dedicated non-anarchistic hierarchy, including the European Union) to an anarchistic condition, qualifies as a level one change. Such a fundamental change is the outcome of a process of social fragmentation; the reverse of the SIE process.

Social integration and expansion (SIE)
Social integration and expansion concerns the scaling of social systems. The SIE process started millennia ago when the first families grouped in

tribes, and is still unfolding. At this point in time circa 7,6 billion humans are grouped in about 220 states.

I argue that the social law that drives SIE consists of five components:

1) The need for humans to fulfill basic requirements to ensure their survival.
2) Population growth.
3) Economies of scale and scope can be achieved in the fulfillment of basic requirements through interacting and cooperating with other humans and social systems.
4) Tensions between actors can be regulated by implementing shared organizational arrangements.
5) Production of free energy (tensions) can be prevented through integration in non-anarchistic structures.

For social structures to be viable, a number of (initial) conditions must be met, as discussed in this study.

For social structures to stay viable, these structures must ensure the balanced fulfillment of their basic requirements.

Starting in 1495 – when Europe reached the percolation condition and started functioning as a system – until 1945, the anarchistic System produced a first finite-time singularity dynamic which was accompanied by four accelerating cycles. The first finite time singularity dynamic was instrumental in the SIE process.

During the unfolding of the finite-time singularity dynamic, Europe transformed from a large number of loosely connected and divers units (in 1495) into a highly integrated system consisting of 25-30 highly standardized states. The same time as this integration process unfolded, Europe – the core of the expanding System – expanded to non-core territories.

When in 1939 the System reached the critical connectivity threshold (in the core of the System), the System experienced a dual phase transition. Through the dual phase transition (the fourth systemic war, the Second World War, 1939-1945) two dedicated non-anarchistic hierarchies and the first global order were simultaneously implemented.

The finite-time singularity dynamic accompanied by four accelerating cycles was constantly powered by population growth of states in the System; population growth in the anarchistic System ensured that enough free energy was produced to ensure the undisturbed unfolding of the singularity dynamic. However, while population growth powered the singularity dynamic, the singularity dynamic 'at the same time' enabled population growth in the System by ensuring a balance between orders and disorder, and between performance and evolvability of the anarchistic System. Population growth and the finite-time singularity dynamic constitute a self-reinforcing (positive feedback) mechanism.

The economic system, technological innovation, the development of organizational structures (the state, and the armies they 'developed'), ideologies that pushed for – and legitimized – expansion, were enablers of the singularity dynamic.

Spreading speed

Spreading speed and 'pace of life' are related concepts. The spreading speed concerns the speed of spreading phenomenon in networks. I assume that this concept also applies to the spreading (speed) of tensions on the System.

The connectivity of a network to a high degree determines its spreading speed. The acceleration of successive cycles of the first finite-time singularity dynamic (1495-1945), can be considered an indication of the development of the pace of life – spreading speed – of the System.

Stability

Stability concerns the property of a system to maintain itself within a certain stability domain; to maintain a certain equilibrium. The (accelerating) need to implement upgraded (international) orders (that 'underlie' relatively stable periods) to maintain 'balance', point to the System's increasing instability.

The instability of the anarchistic System lies in the accelerating production of free energy (tensions) in the System, which is a consequence of the intrinsic incompatibility of (increasing) connectivity and security in anarchistic systems; free energy (tensions) as an internal state grows without bounds.

The equilibrium of the anarchistic System is in other words unstable: the oscillations (cycles) of the anarchistic System accelerated during the unfolding of the first finite-time singularity dynamic (1495-1945): the frequency as well as the amplitudes of successive oscillations accelerated, until the System's collapse in 1939. The dynamics of the current (global) anarchistic System (1945-...) suggest that the current System also is unstable: At this point in time the System is in the first cycle of the second singularity dynamic (1945-...), that will also – I expect – produce a number of accelerating cycles. See also: *Fragility*, Instability, Robustness and *Structural stability*.

State

Levy (38) defines a state as "a political organization commanding a predominance of political power within a given territory and characterized by independence from external hierarchical authority."

From the perspective of this study the state is a specific organizational structure (unit) the anarchistic System produced, during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945). States and international orders coevolved. States are instrumental in the fulfillment of the basic requirements of their populations.

The state is an emergent 'solution' that was contingent on the conditions that prevailed in the anarchistic System during the 1495-1945 period. The powerful-become-more-powerful effect and mutual-empowerment mechanism contributed to the selection of the state as the 'legitimate' unit in the System.

Structural stability

The System (international orders) has besides a certain robustness and fragility, also a certain 'structural stability'. Structural stability refers to the permanence of structures in the System. I define structural stability as an absence of fluctuations in the status hierarchy (organization) and physical distribution of units in the System.
See also: *Stability*, *Robustness* and *Fragility*.

Stocks and flows

Stocks and flows are besides feedbacks the two central concepts of dynamic systems theory. According to Sterman (69), "stocks are accumulations. They characterize the state of the system and generate the information upon which decisions and actions are based." Because stocks define the state of the system, they are also mostly referred to as state variables. "Flows are the rates at which these system states – stocks – change." "Stocks give systems inertia and provide them with memory. Stocks create delays by accumulating the difference between the inflow to a process and its outflow. By decoupling rates of flow, stocks are the source of disequilibrium dynamics in systems." "Stocks accumulate or integrate their flows; the net flow into the stock is the rate of change of the stock." Issues, tensions, and (potential) destructive energy are accumulations that are temporarily 'stocked' in the System. Population growth and the effects it causes are the sources of the inflow, while systemic wars are release events and constitute the outflow. Whereas the inflow is relatively gradual, taking place during the relatively stable periods, the outflow is always abrupt, producing a punctuated equilibrium dynamic.

According to Sterman, stocks are critical in generating the dynamics of systems for a number of reasons:

1 ***"Stocks characterize the state of the system and provide the basis for actions"***

Issues, tensions, and destructive energy characterize the System. Issues, tensions, and the build-up of destructive potential energy are closely monitored by states to determine potential threats and take appropriate actions. Besides continuous population and connectivity growth, and increasing rivalry between states, the security dilemma reinforces their dynamics and effects. Ultimately a global vulnerable cluster will percolate the system and, when triggered, will produce a systemic war.

2 ***"Stocks provide systems with inertia and memory"***

Sterman explains this particular property of stocks as follows: "Stocks accumulate past events. The content of a stock can only change through an inflow or outflow. Without changes in these flows, the past accumulation into the stock persists." This is also the case for the stock of issues, tensions, and destructive energy in the System. Issues, tensions and destructive energy are the outcome of past unresolved events. They increasingly impact on the security of states, cause blockades for further development, and cause the international order to become increasingly dysfunctional (that increasingly undermines its already limited legitimacy). Issues, tensions, and destructive energy themselves do not provide inertia, but rather counter-forces that try to maintain the status quo and prevent the actual use of this destructive potential to create a new order. During relatively stable periods, the inflow and, as a consequence, the stock of issues, tensions, and potential destructive energy, increases, while there is no significant outflow. When a vulnerable cluster has ultimately percolated the System and is triggered, the System produces a systemic war to re-establish order (to implement an upgraded order). A systemic war is a massive release event, causing a fast outflow of the stock. This outflow can, from a more technical perspective, be described as a reset of initial conditions and the parameters of the System.

3 ***"Stocks are the source of delays"***
"All delays involve stocks. A delay is a process whose output lags behind its input." The delays discussed, can all be considered stocks, of which the respective outputs lag behind the respective inputs.

4 ***"Stocks decouple rates of flow and create disequilibrium dynamics"***
"Stocks absorb the differences between inflows and outflows, thus permitting the inflows and outflows to a process to differ. In equilibrium, the total inflow to a stock equals its total outflow so the level of the stock is unchanging." In the case of disequilibrium, that is not the case. Disequilibrium and disorder can be considered synonyms. During the life span of international orders, the System is increasingly in disequilibrium (i.e., the level of disorder increases continuously). At a certain stage when the disequilibrium becomes too large and the system reaches a critical point, a systemic war forces the system back into an (at least temporary) equilibrium. A higher level of disequilibrium means increased dysfunctionality of the System; the dysfunctionality – disequilibrium – of the System was 'complete' when the System 1in 1939 reached the critical connectivity threshold, the singularity in finite-time.

Stored issues, unresolved issues

During high-connectivity regimes of relatively stable periods of cycles, that accompanied the finite-time singularity dynamic (1495-1945), states in the System became increasingly stable as a consequence of the connectivity/local stability effect: Instead of being released, tensions were 'stored' as unresolved issues in the System, and crystallized into vulnerable issue clusters. These stored tensions, formed a so-called free energy release deficit.

The moment the vulnerable issue clusters percolated the System, the System became critical and produced a systemic war. During systemic wars the free energy that had accumulated (was stored) was released and put to work to implement upgraded orders that allow for lower energy states of the System.

Structural instability

Structural instability is a term coined by Kauffman (38), and is not the opposite of 'structural stability'. Structural instability is according to Kauffman a property of a class of dynamical systems. Kauffman distinguishes between structurally stable and instable systems. Structurally stable systems, for most changes in their parameters, "remain within one volume in parameter space and their dynamical behavior does not change dramatically." Their dynamics typically change only slightly as parameters change (...). For some time, it was thought that almost all dynamical systems exhibit this property. However, recent work on strange attractors indicates that a large class of systems, such as a chaotic system, does not exhibit structural stability. In many systems with strange attractors, tuning the parameters leads to "a succession of bifurcations at successively smaller intervals in parameter space."

The System qualifies as a structurally instable system. To use the perspective and terminology of Kauffman: 'tuning' the connectivity of the System happens through population growth and rivalries between states and leads to a succession of bifurcations (systemic wars) at successively smaller intervals. Each systemic war causes a qualitative change in behavior of the System.

In relation to structural instability, Kauffman introduces the idea "that adaptive evolution, or learning in dynamical systems, is achieved by adaptive walks through parameter space to find 'good' dynamical behavior" (*IP: behavior that contributes to the performance of the system).*

Stuck in the middle

This process of expansion and further integration of what has become the European Union, is still ongoing and unfinished. The current condition of Europe – the European Union – can be best described as 'stuck in the middle': states have voluntarily abandoned and transferred typical state functions to a next level of organization ('Brussels'), while at the same time, the next level of organization is not yet fully crystallized and effective in taking over these responsibilities.

The implementation of two dedicated non-anarchistic hierarchies in the core of the System (Europe) through the fourth systemic war, the Second World War (1939-1945), started a 'phased' (step by step) process of integration, in efforts to develop and exploit economies of scale and scope that presented themselves.

The implementation of a 'security community' (22) was followed by the establishment of the European Coal and Steel Community (1951), the European Economic Community (1957), the European Currency Unit (1979), the Schengen Agreement (1985), the European Community (1993), etc. The process is still ongoing. Starting in 1989, former member states of the Eastern hierarchy (which had collapsed) joined this process.

Integration requires that states transfer authority to the next hierarchy (level of integration; to the European Union. This transfer – an ongoing process – complicates the balanced fulfillment of basic requirements of populations in Europe: both states and the European Union, are not (fully) equipped to accomplish adequate balancing (anymore).

At this stage, the European Union and its member states are what I call, 'stuck in the middle'; both states and the European Union are not optimally organized. This stuck in the middle condition makes member states of the European Union, and the Union itself, vulnerable to internal and external challenges that cannot – not anymore and not yet – be adequately addressed. As a consequence, the European Union loses credibility and legitimacy.

From a system- and network-perspective, this particular condition of the European Union – at least in a number of respects – is similar to the condition of the Eastern hierarchy before its collapse in 1989. A lack of internal balance in the European Union can also result in its fragmentation and the re-nationalization of its building blocks (states).

Subdued dynamics of the System

During the second exceptional period (1953-1989) the number of degrees of freedom of the System were also (as was the case during the first exceptional period, 1657-1763) reduced to two; in this particular case as a consequence of the intense rivalry between the United States and the Soviet Union, and the respective hierarchies both 'superpowers' controlled.

However, contrary to the abnormal hyper-excited non-systemic war dynamics during the first exceptional period, during the second exceptional period the non-systemic war dynamics were highly subdued.

During the period 1953-1989 the System produced eight non-systemic wars, all, except for one war, with a size (extent) of one (the exception had a size (extent) of two). Furthermore, all (except for one) wars took place outside Europe. This series of non-systemic wars was non-chaotic (highly subdued) in nature.

I attribute this effect to a deadlock caused by Mutual Assured Destruction (MAD).

Mutual Assured Destruction refers to the 'second strike capability' of the United States and the Soviet Union during the second exceptional period (1953-1989, better known as the 'Cold War'). Both superpowers had ensured through protective measures, precautions, organization and strategies, etc. that under all conditions – including a first nuclear strike from their rival – enough nuclear capabilities would survive, to launch a retaliatory nuclear strike: mutual destruction was assured.

War as an instrument of policy/politics had lost its 'logic' and function. This situation produced a deadlock because of the risks of escalation. Both superpowers were very reluctant to confront each other directly; as far as non-systemic wars occurred during the period 1953-1989, they were very subdued, and for one exception, took place outside of the primary focus (Europe) of the rivalries, in the 'periphery'.

Susceptibility of the System

The System is depending on its particular condition, more or less susceptible for perturbations, incidents and events. In case of a high susceptibility (as is the case during criticality), perturbations propagate through the System.

The susceptibility of the System is determined by a number of 'conditions', including: the existence of vulnerable issue clusters, their size (correlation length), and the connectivity of these vulnerable issue clusters.

During high-connectivity regimes, vulnerable issue clusters 'almost' percolate the System, but due to a connectivity/local stability effect, the System's susceptibility is low.

Switching costs

Switching to another organizational arrangement / international order comes with switching costs. Switching costs include: losing a preferred position, and the privileges it brings, investments in the new arrangement, risks, internal unbalance, etc. Switching costs contribute to the inertia – metastability – of the System.

System

The System consists of sovereign states, non-state actors, institutions, etc. and 'rules' that regulate interactions between these actors. States can be considered the 'building blocks' of the System. The 'geographical space' of the System, its territory, is divided between states, that have more or less control over specified territories and their populations.

States are sovereign and must compete for (scarce) 'resources' to fulfill their basic requirements to ensure their survival. Sovereignty implies that states have 'exclusive' control over (more or less) accurately defined geographical areas (territories) and their populations. States are not supposed to interfere in the internal affairs of other states; states are autonomous.

Although states formally enjoy the same legal (sovereign) status, in other respects states differ fundamentally: in their interests, resources, power they can mobilize and project, their 'views', political system, threats they perceive, status, respect (soft power), influence, their dependency on other states to fulfill their basic requirements, etc.

The System is not only made up of states, but also of rule sets that define how states (and certain institutions) are supposed to (inter) act in the System; these rule-sets evolved over time and are integral parts of (successive) international orders; over time these rule-sets became more comprehensive. Alliances – and their dynamics – also are integral parts of the System.

The System also consists of non-state actors. A distinction can be made between 'formal' non-state actors, with (more or less) defined positions (in relation to states) that (inter)act on the basis of rule-sets states agreed on, like international organizations and institutions, and 'informal' non-state-actors, that include actors that have or claim positions that are not 'formally' 'recognized' by states in the System, or the international order. These non-state actors can operate 'legally' in the System with the explicit or implicit authorization of states and/or the international order, or are considered illegal by (certain) states or the international order. Terrorists organizations fall in the last category. In anarchistic systems the 'position' of non-state actors can be contested and be part of its dynamics.

The System can be considered a network of states (and other actors) that interact on the basis of certain rules. The connectivity of this network is an important property, that can be considered the control parameter of the System. The connectivity impacts (in) directly on a number of properties of the System and its dynamics, including: its robustness, fragility, structural stability, and its pace of life. The connectivity of the anarchistic System also determines the amounts of free energy (tensions) the System produces.

The System is anarchistic in nature; (increasing) connectivity and security are intrinsically incompatible in anarchistic systems and le(a)d to the production of free energy (tensions) in the System. The System – its 'order – is more or less functional in supporting the fulfillment of basic requirements of states (and non-state actors.

Physical laws also apply to the free energy that is produced by the System; the second law of thermodynamics ensures – enforces – that free energy (tensions) is put to work to implement upgraded orders that allow for a lower energy state of the System. The combination of free energy produced by the System and application of this law resulted in the finite-time singularity accompanied by four accelerating cycles that unfolded in the System during the 1495-1945 period, and also is the driver of the (second) singularity dynamic that is now unfolding (1945-...).

The System has a certain (degree of) organization. Systemic wars – as I argue in this study – are the means by which states 'collectively' decide on, and implement (upgraded) organizational arrangements that underpin international orders. Dominant states typically are in a more influential position to decide on the arrangements that underpin international orders. A powerful-become-more-powerful effect shaped the (increasingly) path dependent co-evolutionary dynamics between states and (successive) international orders, during the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945): The finite-time singularity dynamic and 'accompanying' systemic wars can be seen as a selection process, in which more powerful states acquired more influential positions.

When the System was rebalanced through upgraded orders that were designed and implemented through systemic wars, these upgraded orders provided a certain structural stability and robustness; these properties ensured that (increasingly) interdependent states and their populations could fulfill their basic requirements and experience further grow.

The System, and the finite-time singularity dynamic that unfolded during the 1495-1945 period, had (and have) to fulfill a specific function: to ensure the fulfillment of basic requirements by uneven states in an anarchistic System to ensure their (collective) survival. The performance and evolvability of the System determine(d) to what extent the System could (and can) accomplish its functions. The System – in compliance with the second law of thermodynamics – ensured its sustained performance by periodically upgrading its international orders; the ability to achieve this, is indicative for the evolvability of the System.

From a complex system perspective, the System – its successive international orders – qualifies as a self-organized system, a system that through its internal/intrinsic dynamics – a multitude of interactions between its components – produced emergent macro structures, that lacked any top-down or deliberate design. Although the organizational arrangements that underpin(ned) successive international orders are deliberate and man-made, the underlying dynamic is not: it was (and is) the (unavoidable) obedience of the System to the second law of thermodynamics that resulted in the implementation of successive upgraded orders in the deterministic domain of the System. These successive orders provided the structures in the contingent domain of the System, to develop and utilize these structures to integrate the components (units and states) of the System; the contingent domain had no other options than to comply with the 'underlying' deterministic dynamics. The underlying deterministic dynamics initiated (increasingly) path dependent integrative dynamics in the contingent domain of the System, that locked-in on a next level of SIE (social expansion and integration).

The System has a certain 'reach'; with reach I refer to the geographical area that was shaped – 'controlled' – by the first finite singularity dynamic (1495-1945).

Until 1495 Europe did not constitute a system; until then Europe consisted of a large number of diverse and loosely connected units. Around 1495 these units became sufficiently connected to develop system-behavior. The finite-time singularity constitutes this system-behavior. Ultimately, when the anarchistic System in 1939 reached the critical connectivity threshold, produced infinite amounts of free energy (tensions) and collapsed as a consequence, the System (Europe) consisted of only a relatively few number of highly standardized and highly connected states; states were organized to produce and deploy increasing amounts of destructive energy, to ensure their survival in the System.

The process of integration in Europe – in what would become the core of the expanding System – went hand-in-hand with a process of expansion of European states outside Europe. The process of integration and expansion co-evolved and reinforced each other. For that reason, the phase transition the System experienced through the fourth systemic war (the Second World War, 1939-1945) had two 'dimensions', and I refer to as a dual phase transition: At the same time when two dedicated non-anarchistic hierarchies were implemented in Europe – in the core of the System – the first global international order was implemented at a global scale of the anarchistic System. These orders were complementary.

From a physics perspective the anarchistic System qualifies as a dynamical non-equilibrium system. During the unfolding of the finite-time singularity dynamic accompanied by four accelerating cycles (1495-1945) the anarchistic System became increasingly unstable and collapsed (in 1939) and produced in response a phase transition (1939-1945).

In part II I discuss a number of perspectives that focus on specific dynamics and properties of the System.

System dynamics

System dynamics provides a powerful perspective and set of conceptual tools that enable us to understand the structure and dynamics of complex systems. System dynamics seeks endogenous explanations for phenomena.

This perspective helps us understand how the dynamics of the System are related to its structure and vice versa. A fundamental principle of system dynamics is that the structure of the system gives rise to its behavior. Sterman (69) distinguishes three central concepts in system dynamics: feedback process, stocks, and flows.

Systemic release event

During the unfolding of the first and second singularity dynamics (respectively 1495-1945 and 1945-...) two types of energy releases can be distinguished in the deterministic domain of the anarchistic System: systemic and non-systemic release events that correspondent respectively with systemic and non-systemic wars in the contingent domain of the System. Release events – systemic and non-systemic – obey the second law of thermodynamics. Systemic release events (systemic wars) are equivalent with criticality of the System.

Systemic war

Two fundamentally different types of war can be distinguished: systemic wars and non-systemic wars. The fundamental difference lies in their function, and a number of their properties.

Systemic wars are contingent manifestations of criticality of the anarchistic System.

Because of the intrinsic incompatibility between (increasing) connectivity and security in anarchistic systems, anarchistic systems produce free energy (tensions in the contingent domain). The second law of thermodynamics applies to the free energy that is produced in the System, and to ensure consistency with the 'demands' of this law, free energy is periodically put to work in the anarchistic System through systemic wars, to implement upgraded orders that allow for lower energy states of the System.

Systemic wars are 'ordering' forces, that use the typical properties of critical systems – a correlation length of one, that enables system-wide communication, coordination and planning – to collectively design and implement upgraded orders.

It is possible to distinguish three related and overlapping phases during systemic wars:

1) Destruction of issues and tensions.
2) Design of an upgraded order that meets the requirements of all – especially – dominant states in the System.
3) Implementation of the upgraded order.

Both systemic and non-systemic wars are highly deterministic in nature. As explained in this study, the war dynamics of the System developed very regularly and predictably. The timing, duration as well as the amounts of free energy that will be released, are highly predictable properties of systemic wars. The unpredictability of the non-systemic wars, lies in their chaotic nature.

Tensions

Anarchistic systems produce free energy – tensions in the contingent domain of the System – as a consequence of the intrinsic incompatible between (increasing) connectivity and security in these type of systems. Humans, and social systems are 'carriers' of tensions. Because tensions are (in some respects) equivalent with energy, a number of properties that apply to (free) energy also apply to tensions in the System. Tensions can be considered 'potential' (destructive) energy; tensions can be transformed in destructive energy. The second law of thermodynamics applies to the free energy – tensions – that is produced in the System.

Rivalries between states, the security dilemma and interacting self-fulfilling prophecies contribute to higher tensions levels in the System.

I assume that tensions are 'transformed' in destructive energy. Destructive energy can be deployed as 'threats', or be actually put to use during war. I consider the severities of wars – in terms of battle casualty deaths of military personnel of Great Powers – an indication for the amount of free energy – tensions – the System had produced and the amount of destructive energy that is deployed during these wars.

Tensions – (free) energy – in the System, can be:

1) put to work through war, to (re-establish order);
2) stored in the form of unresolved issues and tensions, as is for example the case during high-connectivity regimes of relatively stable periods;
3) crystallize in vulnerable issue clusters with fractal structure, as is the case during high-connectivity regimes of relatively stable periods;
4) transformed in destructive energy, that is actually used, or is used in a 'potential' form (in case of preventive deployments, or as threats);
5) dissolved by solving the issues that produce tensions;
6) neutralized by destruction or by negotiation;
7) reactivated, become 'active' again (re-emerge) after temporary storage, or in a later stage as an unresolved issue;
8) transferred between humans, and social systems;
9) multiplied by humans and social systems.

Threat

"A threat may be defined as an act that creates a conditional expectation of damage, conditional on the performance (or perhaps, nonperformance) of some other act; it typically has the form, "If you do (or do not do) A, I will do B." A threat is simply a negative promise. A threat may be conscious and explicit, or it may be merely implied in a situation. The significance of a threat lies wholly in the way it is perceived by the parties."

"The image of the threat in the minds of the parties depends partly on the perception of the means to carry it out and partly on belief about the will to carry it out." (15).

Threats states perceive are subjective in nature, and depend for example on the basic requirements states must fulfill, identity and ideology, power, influence and military capabilities that are available, but also on the 'position' of other states regarding issues. Threats are dynamic.

Threshold

The term thresholds is used with a number of different meanings in this study.

1 *Decision thresholds*

War decisions in the System qualify as binary decisions with thresholds and externalities. States apply, mostly implicitly, thresholds that define when they switch to positive war decisions. The number and properties of incoming signals that trigger a positive war decision by states define their respective thresholds. Thresholds are properties of states. The thresholds that states apply, explicitly or implicitly, are a function of their basic requirements, perceived threats and tensions, and issues the state is connected with. Different states apply different thresholds, and the thresholds of particular states are dynamic. With respect to thresholds of states, the System qualifies as a heterogeneous network.

Thresholds of states are not expressed in terms of the absolute number of a state's 'neighbors' that choose a given alternative ('war' or 'no war'), but the corresponding fraction of connected states. "This is a natural condition to impose for decision-making problems, because the more signals a decision maker receives, the less significant any one signal becomes (72)."

2 *Thresholds through local stability*

The anarchistic System has the ability to spend extended time in a configuration (relatively stable period, international order) that is not the System's state of least energy: Although the anarchistic System during relatively stable periods releases energy through non-systemic wars, at a certain point (the tipping point of relatively stable periods) when the System reaches a high-connectivity regime, the local stability of states in the System increasingly prevents the anarchistic System from releasing free energy (tensions). During high-connectivity regimes, instead of being released tensions (free energy) are stored in the System, form a free energy release deficit, and crystallize in vulnerable issue clusters with fractal structures. The moment the vulnerable issue clusters percolate the System, the System becomes critical and produces a systemic war. During systemic wars the tensions (free energy) that are stored in the System are put to work to implement upgraded orders, that allow for lower energy states of the System. The local stability of states during high-connectivity regimes work as thresholds that allow the System to spend extended time in a metastable condition, to 'charge', and eventually produce a systemic war.

In the contingent domain of the System, besides the incentives of dominant states to maintain 'their' privileged international orders a number of 'factors' contribute (indirectly) to the System's metastability.
See also: *Slowly driven, interaction-dominated threshold systems.*

Tipping point
The tipping point of a relatively stable period (international order) divides the low- and high-connectivity regime. When the tipping point is reached, the local stability of states in the System starts to impact the size of non-systemic wars. From that moment onward, the size of non-systemic wars starts to decrease and multiple 'islands' of local stability emerge.
See also: *Cascade(s).*

Top-down mechanism
Two interacting mechanisms determined and shaped the sizes and size distribution of states in the anarchistic System, consistent with the requirements of the second law of thermodynamics. I refer to these mechanisms respectively as a 'bottom up' and a 'top down' mechanism.

1 ***Bottom up***
The bottom-up mechanism concerns a mechanism that works at the level of states and their populations. Two forces compete at this level: a force pushing for increased size of the state to exploit more economies of scale and scope, to fulfill basic requirements, and a force that put limits to expansion, because of the increasing challenges that must be confronted to ensure adequate integration, in case of a larger state. There is an optimum, of course. Finding and maintaining this optimum is a dynamic process, and depends on a number of factors and conditions, for example the cultural diversity of the state, etc. This process is still unfolding in Europe, at the EU-level (the level of the super-imposed non-anarchistic hierarchy).

2 ***Top down***
The top-down mechanism concerns a mechanism that works at the level of the system. The anarchistic System consists of 'independent' states (units) that produce free energy (tensions) because of the intrinsic incompatibility between (increasing) connectivity and security in anarchist systems. The second law of thermodynamics applies to the free energy (tensions) that

is produced in the System. The second law of thermodynamics puts free energy (tensions) to work to implement upgraded orders that allow for lower energy states in the System. In the anarchistic System, tensions are put to work through systemic wars to implement (upgraded) international orders.

During the unfolding of the finite-time singularity dynamic (1495-1945), both mechanisms – both concerned with the fulfillment of basic requirements and survival of states – increasingly interacted. The interaction between both mechanisms determined the sizes of states in the System (and thus the eventual number of states in Europe), and their (fractal) size-distribution. The anarchistic System (in Europe) reached its optimal 'condition' during the fourth international order (1981-1939) shortly before its collapse in 1939.

Unit

With unit I refer to the components – building blocks – of the System: city-states, leagues, and states for example. Initially at the inception of the System around 1495, the anarchistic System (Europe) consisted of a variety of relatively small units, that were sparsely connected, shortly before its collapse in 1939 when the System reached the critical connectivity threshold, the System consisted of a relatively small number of significant larger highly standardized and highly connected states. At that stage the size-distribution of states could be best described with a power-law, pointing to the fractal nature of states in the System. The transformation of the System – of its components, and its properties – was accomplished by the finite-time singularity accompanied by four accelerating cycles, that unfolded in the System during the period 1495-1939 to ensure compliance of the System with the second law of thermodynamics. This transformation process (1495-1945) can be considered a step in a (much) longer process of social integration and expansion, that was 'powered' by population growth (of states) in the System.

Unpredictability at the critical point

Bak (5) described the problem in predicting particular avalanche events and the impact of contingency as follows: "The dynamics of the non-equilibrium critical state could hardly be more different than the quiet dynamics of a flat beach. How would a local observer experience the situation? During the transient stage, when the sandpile was relatively shallow, his experience would be monotonous. Every now and then there would be a small disturbance passing by, when a few grains topple in the neighborhood. If we drop a single grain of sand at one place instead of another, this causes only a small local change in the configuration. There is no means by which the disturbance can spread system-wide. The response to small perturbations is small. In a noncritical world nothing dramatic ever happens. It is easy to be a weather (sand) forecaster in the flatland of a noncritical system. Not only can he predict what will happen, but he can also understand it, to the limited extent that there is something to understand. The action at some place does not depend on events happening long before at far-away places.

Contingency is irrelevant. Once the pile has reached the stationary critical state, though, the situation is entirely different. A single grain of sand might cause an avalanche involving the entire pile. A small change in the configuration might cause what would otherwise be an insignificant event to become a catastrophe. The sand forecaster can still make short time predictions by carefully identifying the rules and monitoring his local environment. If he sees an avalanche coming, he can predict when it will hit with some degree of accuracy. However, he cannot predict when a large event will occur, since this is contingent on very minor details of the configuration of the entire sandpile."

"In physics, critical phenomena are the collective name associated with the physics of critical points. Most of them stem from the divergence of the correlation length (...). Critical phenomena include scaling relations among different quantities, power-law divergences of some quantities (such as the magnetic susceptibility in the ferromagnetic phase transition) described by critical exponents, universality, fractal behavior, ergodicity breaking. Critical phenomena take place in second order phase transition, although not exclusively."

"The most important is susceptibility *(for a system in a critical condition, IP).* Bak explains that a system in a critical condition with a fractal structure can easily propagate perturbations. A change in a fractal structure, at a certain scale, can affect 'the next-scale clusters, and the perturbation climbs the ladder until the whole system changes radically'. Thus, critical systems are very sensitive to small changes in the environment."

"The sand forecaster's situation is similar to that of the weatherman in our complex world: by experience and data collection he can make 'weather' forecasts of local grain activity, but this gives him little insight into the 'climate', represented by the statistical properties of many sand slides, such as their size and frequency. Most of the time things are completely calm around him, and it might appear to him that he is actually living in a stable equilibrium world, where nature is in balance. However, every now and then his quiet life is interrupted by a punctuation: a burst of activity where grains of sand keep tumbling around him. There will be bursts of all sizes. He might be tempted to believe that he is dealing with a local phenomenon since he can relate the activity that he observes to the dynamical rules of the sand toppling around him. But he is not; the local punctuation that he observes is an integrated part of a global cooperative phenomenon. (*IP: The 'scenario' that Bak described here is similar to, for example, the condition of the System shortly before the outbreak of the First World War (the third critical point, the third systemic war), and how it was and still is (wrongly) understood by most historians, not aware of the defining impact of the dynamics of the underlying network*). Parts of the critical system cannot be understood in isolation. The dynamics observed locally reflect the fact that it is part of an entire sandpile. If you were sitting on a flat beach instead of a sandpile, the rules that govern the sand are precisely the same, following the same laws of physics, but history has changed things. The sand is the same but the dynamics are different. The ability of the sand to evolve slowly is associated with its capability of recording history." "This cannot happen in an equilibrium system such as a dish of water. In the critical state, the sandpile is the functional unit, not the single grains of sand. No reductionist approach makes sense. The local units exist in their actual form, characterized for instance by the local slope, only because they are a part of a whole. Studying the individual grains under the microscope doesn't give a clue as to what is going on in the whole sandpile. Nothing in the individual grain of sand suggests the emergent properties of the pile. The sandpile goes from one configuration to another, not gradually, but through catastrophic avalanches."

The same is the case for the System at a critical point. At that point, the correlation length of the System is 'one' and the System is (as a consequence) highly susceptible for perturbations; this means (as is the case for Bak's sandpile) that the System at the point has become the 'functional unit' and that a reductionist approach to explain its dynamics does not apply any longer. Events and incidents, as well as the reactions they cause by states, now impact on the entire System. "Because of the power law statistics, most of the topplings are associated with the large avalanches. The much more frequent small avalanches do not add up too much. Evolution of the sandpile takes place in terms of revolutions, as in Karl Marx's view of history. Things happen by revolutions, not gradually, precisely because dynamical systems are poised at the critical state. Self-organized criticality is nature's way of making enormous transformations over short time scales. In hindsight one can trace the history of a specific large avalanche that occurred. Sand slides can be described in a narrative language, using the methods of history rather than those of physics."

"The story that the sand forecaster would tell us goes something like this: 'Yesterday morning at 7 A.M., a grain of sand landed on site A, with coordinates (5,12). This caused a toppling to site B at (5,13). Since the grain of sand resting at B was already near the limit of stability, this caused further topplings to sites C, D, and E. We have carefully monitored all subsequent topplings, which can easily be explained and understood from the known laws of sand dynamics, as expressed in the simple equations. Clearly, we could have prevented this massive catastrophe by removing a grain of sand at the initial triggering site'. Everything is understood.

"However, this is a flawed line of thinking for two reasons. First, the fact that this particular event led to a catastrophe depended on the very details of the structure of the pile at that particular time. To predict the event, one would have to measure everything everywhere with absolute accuracy, which is impossible. Then one would have to perform an accurate computation based on this information, which is equally impossible. For earthquakes, we would have to know the detailed fault structure and the forces that were acting on those faults everywhere in a very large region, like California. Second, even if we were able to identify and remove the triggering grain, there would sooner or later be another catastrophe, originating somewhere else, perhaps with equally devastating consequences."

"But most importantly, the historical account does not provide much insight into what is going on, despite the fact that each step follows logically from the previous step. The general patterns that are observed even locally, including the existence of catastrophic events, reflect the fact that the pile had evolved into a critical state during its entire evolutionary history, which took place on a much longer time scale than the period of observation. The forecaster does not understand why the arrangement of grains happened to be precisely such that it could accommodate a large avalanche. Why couldn't all avalanches be small? There is not much that an individual can do to protect himself from these disasters. Even if he is able to modify his neighborhood by flattening the pile around him, he might nevertheless be swept away by avalanches from far away, through no fault of his own. Fate plays a decisive role for the sandpile inhabitant. In contrast, the observer on the flat noncritical pile can prevent the small disasters by simple local measures, since he needs information only about his neighborhood in order to make predictions, assuming that he has information on the arrival of grains to the pile. It is the criticality that makes life complicated for him."

As Bak observed, depending on the exact configuration of a system, 'what would otherwise be an insignificant event can become a catastrophe'. This is also the case for the System; the start of the First World War (the third systemic war, 1914-1918), through a relatively minor incident, is a case in point. Until today, historians try to identify and explain events that eventually resulted in the First World War. They however were and are not aware that, at that stage (1914), the System had reached a critical condition: the development of the System toward a critical condition in 1914 had already started back in 1815 when a new international order was implemented. The timing of 'criticality'—of all critical points of all systemic wars—was contained in the initial conditions of the System at the inception of the finite-time singularity in 1495. Historians believe that the assassination of Archduke Franz Ferdinand, and the destructive war that then emerged, can be understood and explained by (re)constructing highly contingent and often illusionary causalities between events preceding the First World War. Because of this perspective, the First World War is often seen as avoidable and irrational. As this study shows, these observations and qualifications are not correct: Because the System had reached a critical condition the assassination of Archduke Franz Ferdinand in Sarajevo in June 1914 triggered a system-wide response. At that point the System was functional unit and incidents and events (and reactions by states they evoked) now impacted on the whole System; as a consequence, its dynamics cannot be understood and explained through a reductionist approach, the diverse (and often contradictory) interpretations of the First World War (and events that preceded it) by historians are a manifestation of this phenomenon.

Urge to survive

In order to survive humans must fulfill a set of basic requirements. The (fulfillment of these) basic requirements must be balanced. The (relative) importance of basic requirements is different, and can change over time.

The urge to survive is at the basis of the 'Social law of SIE'.

Volatility index (VIX)

I define the volatility index (VIX) of the anarchistic System as the product of the frequency and the average size (in terms of fraction) of non-systemic wars constituting six (low- and high-connectivity) war clusters, that can be identified during the first three relatively stable periods of the finite-time singularity dynamic (1495-1945) which was accompanied by four accelerating cycles. The VIX decreased linearly during the unfolding of the finite-time singularity dynamic, suggesting that distortions in one of the properties (frequency and average size) was compensated by the other.

Vulnerable issue

If an issue is one step, that is, one additional positive war decision of a connected state, from activating a war, the issue is considered vulnerable. Issues are connected, and a single switch to war can – depending on the properties of the network – cause a cascade of wars as in a domino effect.
See also: *Cascade dynamics, cascades triggered by shocks, Issue (s) (Issue clusters, Vulnerable issue clusters).*

War

Levy (38) defines war conceptually as "a substantial armed conflict between the organized military forces of independent political units." Levy distinguishes between two subsets of wars: (1) wars involving the Great Powers and (2) interstate wars involving the Great Powers that "consists of wars with at least one Great Power on each side of the conflict. These wars are labeled Great Power wars." Levy operationalizes the criterion "substantial" by requiring a minimum of 1000 battle-deaths, defined as the number of deaths of military personnel.

War clusters

During relatively stable periods (international orders) it is possible to distinguish low- and high-connectivity regimes limited by tipping points. Non-systemic wars that occur during low- and high-connectivity regimes, can be respectively grouped in low- and high connectivity war clusters. The development of these war clusters show remarkable regularities, consistent with the theory that is proposed in this study.

War dynamics

The anarchistic System produce energy releases that manifest themselves as wars. Physical laws apply to the energy (tensions) that is produced and released in the System. The process of energy production and release is determined and shaped by physical laws, including the second law of thermodynamics; I refer to this process as the war dynamics of the System.

The war dynamics of the System are deterministic in nature, and develop(ed) very regularly. The war dynamics of the anarchistic System are instrumental in a process of social integration and expansion (SIE).

War fighting (capabilities)
War fighting capabilities comprise the abilities of units to organize, produce, and mobilize for the deployment of destructive energy.

War trap
With the term 'war trap', I refer to an intrinsic 'logic' of anarchistic systems and finite-time-singularities the System produced during the 1495-1945 period and 1945- ..., that 'push' state towards (systemic) war. States feel forced to apply this war logic to ensure the fulfillment of their basic requirements and their survival. The security dilemma, interacting self-fulfilling prophecies and the co-evolution of states and successive international orders (1495-1945, pushing states to deploy increasing amounts of destructive energy) for example constitute components of the war traps of anarchistic systems.

War system
The anarchistic System can also be depicted as a highly optimized non-equilibrium System that periodically – consistent with the demands of the second law of thermodynamics – produces energy releases to maintain a functional balance between order and disorder, to ensure its performance and evolvability.

In the contingent domain of the anarchistic System, these energy releases manifest themselves as wars. From the perspective of the contingent domain the System could be seen as a war-system; a system that is highly geared to produce wars.

From such a perspective, states are integral components of a network of issues and other states, and constitute war-switches: binary switches ('war' or 'no-war') that are regulated by thresholds (these states apply to their decisions).

War window
It is possible to identify a 'war window' for the System; this window is limited by a lower and upper phase transition (72). War dynamics also require a minimum connectivity of the System to emerge. The minimum connectivity level of the System corresponds to the lower phase transition in Watts' model, and was reached in 1495. The upper phase transition was reached in 1939. At that stage, the connectivity of the anarchistic System reached a critical threshold, prohibiting (non-systemic) cascades. Because the connectivity of the System at that stage made cascades impossible, while at the same time

tensions and free energy were building up in 'infinite' amounts, the System was forced to transit to a fundamentally different phase. As a consequence of its increasing connectivity, the anarchistic System (i.e., Europe) was in fact pushed out of the war window and forced to undergo a phase transition. See also: *Cascade window* and *Cascade dynamics, cascades triggered by shocks*.

Western hierarchy

See: *Dedicated hierarchy*.

Zipf's law

The regularity expressed by straight lines in logarithmic plots of rank versus frequency, is referred to as Zipf's law.

DATA

War data Levy

Below tables (137 and 138) show Levy's war data (38). For (complementary) war data see table 31.

Table 128 *This table shows the war data of Levy (38). I have marked systemic wars in red: (1) wars 46-49 constitute the first systemic war (The Thirty Years' War), (2) wars 84-85 constitute the second systemic war (the French Revolutionary and Napoleonic Wars), (3) war 107 constitutes the third systemic war (The First World War), and (4) war 113 constitutes the fourth systemic war (The Second World War). Wars 58-77 constitute non-systemic wars during the first exceptional period (1657-1763), and are marked in purple. Wars marked in yellow are expansion wars (numbers: 88, 97, 99, 104, 105, 109, 110, 111 and 112). For names of wars see below table (table 138).*

Nr. Levy	Start	End	Duration	Number GP	Extent	Fraction	Magnitude	Concentration	Intensity	Severity
1	1495	1497	2.0	5	3	0.60	1.20	1,333	119	8,000
2	1497	1498	1.0	5	1	0.20	0.20	3,000	45	3,000
3	1499	1503	4.0	5	1	0.20	0.80	1,000	60	4,000
4	1499	1500	1.0	5	1	0.20	0.20	2,000	29	2,000
5	1501	1504	3.0	5	2	0.40	1.20	3,600	269	18,000
6	1508	1509	1.0	5	3	0.60	0.60	3,333	145	10,000
7	1511	1514	3.0	5	4	0.80	2.40	1,500	261	18,000
8	1512	1519	7.0	5	2	0.40	2.80	1,714	343	24,000
9	1513	1515	2.0	5	1	0.20	0.40	2,000	57	4,000
10	1515	1515	0.5	5	3	0.60	0.30	2,000	43	3,000
11	1521	1526	5.0	4	3	0.75	3.75	2,000	420	30,000
12	1521	1531	10.0	4	2	0.50	5.00	3,400	958	68,000
13	1522	1523	1.0	4	1	0.25	0.25	3,000	41	3,000
14	1526	1529	3.0	4	3	0.75	2.25	2,250	249	18,000
15	1532	1535	3.0	4	2	0.50	1.50	4,667	384	28,000
16	1532	1534	2.0	4	1	0.25	0.50	2,000	55	4,000
17	1536	1538	2.0	4	2	0.50	1.00	8,000	438	32,000
18	1537	1547	10.0	4	2	0.50	5.00	4,850	1329	97,000
19	1542	1550	8.0	4	1	0.25	2.00	1,625	176	13,000
20	1542	1544	2.0	4	2	0.50	1.00	11,750	629	47,000
21	1544	1546	2.0	4	2	0.50	1.00	2,000	107	8,000
22	1549	1550	1.0	4	2	0.50	0.50	3,000	79	6,000
23	1551	1556	5.0	4	2	0.50	2.50	4,400	578	44,000
24	1552	1556	4.0	4	2	0.50	2.00	6,375	668	51,000
25	1556	1562	6.0	5	2	0.40	2.40	4,333	676	52,000

Nr. Levy	Start	End	Dura-tion	Number GP	Extent	Fraction	Magni-tude	Concen-tration	Inten-sity	Severity
26	1556	1559	3.0	5	3	0.60	1.80	3,000	316	24,000
27	1559	1560	1.0	5	2	0.40	0.40	4,000	78	6,000
28	1559	1564	5.0	5	2	0.40	2.00	2,400	310	24,000
29	1562	1564	2.0	5	2	0.40	0.80	1,500	77	6,000
30	1565	1568	3.0	5	2	0.40	1.20	4,000	306	24,000
31	1569	1580	11.0	5	2	0.40	4.40	2,182	608	48,000
32	1576	1583	7.0	5	2	0.40	2.80	3,429	600	48,000
33	1579	1581	2.0	5	1	0.20	0.40	2,000	50	4,000
34	1583	1590	7.0	5	1	0.20	1.40	2,429	210	17,000
35	1585	1604	19.0	5	2	0.40	7.60	1,263	588	48,000
36	1587	1588	1.0	5	1	0.20	0.20	4,000	49	4,000
37	1589	1598	9.0	5	2	0.40	3.60	889	195	16,000
38	1593	1606	13.0	5	2	0.40	5.20	3,462	1086	90,000
39	1600	1601	1.0	5	1	0.20	0.20	2,000	24	2,000
40	1610	1614	4.0	6	2	0.33	1.33	1,875	175	15,000
41	1615	1618	3.0	6	1	0.17	0.50	2,000	70	6,000
42	1615	1617	2.0	6	1	0.17	0.33	1,000	23	2,000
43	1617	1621	4.0	7	1	0.14	0.57	1,250	58	5,000
44	1618	1619	1.0	7	2	0.29	0.29	3,000	69	6,000
45	1618	1621	3.0	7	1	0.14	0.43	5,000	173	15,000
46	1618	1625	7.0	7	4	0.57	4.00	20,267	3535	304,000
47	1625	1630	5.0	7	6	0.86	4.29	11,615	3432	302,000
48	1630	1635	5.0	7	4	0.57	2.86	15,700	3568	214,000
49	1635	1648	13.0	7	5	0.71	9.29	17,708	12933	1,151,000
50	1642	1668	26.0	7	1	0.14	3.71	3,077	882	80,000
51	1645	1664	19.0	7	1	0.14	2.71	3,790	791	72,000
52	1648	1659	11.0	7	2	0.29	3.14	4,909	1187	108,000
53	1650	1651	1.0	7	1	0.14	0.14	2,000	22	2,000
54	1652	1655	3.0	7	2	0.29	0.86	4,333	282	26,000
55	1654	1660	6.0	7	3	0.43	2.57	1,833	238	22,000
56	1656	1659	3.0	7	2	0.29	0.86	2,500	161	15,000
57	1657	1661	4.0	7	1	0.14	0.57	1,000	43	4,000
58	1657	1664	7.0	7	3	0.43	3.00	8,385	1170	109,000
59	1665	1666	1.0	7	1	0.14	0.14	1,000	11	2,000
60	1665	1667	2.0	7	3	0.43	0.86	6,167	392	37,000
61	1667	1668	1.0	7	2	0.29	0.29	2,000	42	4,000
62	1672	1678	6.0	7	6	0.86	5.14	10,364	3580	342,000

Nr. Levy	Start	End	Duration	Number GP	Extent	Fraction	Magnitude	Concentration	Intensity	Severity
63	1672	1676	4.0	7	1	0.14	0.57	1,250	52	5,000
64	1677	1681	4.0	7	1	0.14	0.57	3,000	125	12,000
65	1682	1699	17.0	7	2	0.29	4.86	11,294	3954	384,000
66	1683	1684	1.0	7	2	0.29	0.29	2,500	51	5,000
67	1688	1697	9.0	7	5	0.71	6.43	15,111	6939	680,000
68	1700	1721	21.0	6	2	0.33	7.00	2,370	640	64,000
69	1701	1713	12.0	6	5	0.83	10.00	20,850	12490	1,251,000
70	1716	1718	2.0	5	1	0.20	0.40	5,000	98	10,000
71	1718	1720	2.0	5	4	0.80	1.60	3,125	245	25,000
72	1726	1729	3.0	5	2	0.40	1.20	2,500	144	15,000
73	1733	1738	5.0	5	4	0.80	4.00	4,400	836	88,000
74	1736	1739	3.0	5	2	0.40	1.20	6,333	359	38,000
75	1739	1748	9.0	6	6	1.00	9.00	8,159	3379	359,000
76	1741	1743	2.0	6	1	0.17	0.33	5,000	94	10,000
77	1755	1763	8.0	6	6	1.00	8.00	26,105	9118	992,000
78	1768	1774	6.0	6	1	0.17	1.00	2,333	127	14,000
79	1768	1772	4.0	6	1	0.17	0.67	3,500	149	14,000
80	1778	1779	1.0	6	2	0.33	0.33	150	3	300
81	1778	1784	6.0	6	3	0.50	3.00	2,267	304	34,000
82	1787	1792	5.0	6	2	0.33	1.67	192,000	1685	192,000
83	1788	1790	2.0	6	1	0.17	0.33	1,500	26	3,000
84	1792	1802	10.0	6	6	1.00	10.00	13,000	5816	663,000
85	1803	1815	12.0	6	6	1.00	12.00	32,224	16112	1,869,000
86	1806	1812	6.0	6	2	0.33	2.00	6,429	388	45,000
87	1808	1809	1.5	5	1	0.20	0.30	4,000	51	6,000
88	1812	1814	2.5	5	1	0.20	0.50	1,600	34	4,000
89	1815	1815	0.5	5	1	0.20	0.10	10,000	17	2,000
90	1823	1823	0.9	5	1	0.20	0.18	667	3	400
91	1827	1827	0.1	5	3	0.60	0.06	1,800	2	180
92	1828	1829	1.0	5	1	0.20	0.20	35,714	415	50,000
93	1848	1849	1.0	5	1	0.20	0.20	5,600	45	5,600
94	1849	1849	1.2	5	1	0.20	0.24	2,083	20	2,500
95	1849	1849	0.2	5	2	0.40	0.08	1,500	4	600
96	1853	1856	2.4	5	3	0.60	1.44	35,000	1743	217,000
97	1856	1857	0.4	5	1	0.20	0.08	1,250	4	500
98	1859	1859	0.2	5	2	0.40	0.08	50,000	159	20,000
99	1862	1867	4.8	6	1	0.17	0.80	1,667	64	8,000

Nr. Levy	Start	End	Dura-tion	Number GP	Extent	Fraction	Magni-tude	Concen-tration	Inten-sity	Severity
100	1864	1864	0.5	6	2	0.33	0.17	1,500	12	1,500
101	1866	1866	0.1	6	3	0.50	0.05	113,333	270	34,000
102	1870	1871	0.6	6	2	0.33	0.20	150,000	1415	180,000
103	1877	1878	0.7	6	1	0.17	0.12	171,429	935	120,000
104	1884	1885	1.0	6	1	0.17	0.17	2,100	16	2,100
105	1904	1905	1.6	7	1	0.14	0.23	28,125	339	45,000
106	1911	1912	1.1	8	1	0.13	0.14	5,454	45	6,000
107	1914	1918	4.3	8	8	1.00	4.30	258,672	57616	7,734,300
108	1918	1921	3.0	7	5	0.71	2.14	385	37	5,000
109	1931	1933	1.4	7	1	0.14	0.20	7,143	73	10,000
110	1935	1936	0.6	7	1	0.14	0.09	6,667	29	4,000
111	1937	1941	4.4	7	1	0.14	0.63	56,819	1813	250,000
112	1939	1939	0.4	7	2	0.29	0.11	22,857	116	16,000
114	1939	1940	0.3	7	1	0.14	0.04	166,667	362	50,000
113	1939	1945	6.0	7	7	1.00	6.00	462,439	93665	12,948,300
115	1950	1953	3.1	5	4	0.80	2.48	84,510	6821	954,960
116	1956	1956	0.1	6	1	0.17	0.02	70,000	50	7,000
117	1956	1956	0.1	6	2	0.33	0.03	300	0	30
118	1962	1962	0.1	6	1	0.17	0.02	5,000	1	500
119	1965	1973	8.0	6	1	0.17	1.33	7,000	90	56,000

Table 129 *Names of wars (see table 137).*

1	War of the League of Venice*
2	Polish-Turkish War
3	Venitian-Turkish War
4	First Milanese War
5	Neapolitan War*
6	War of the Cambrian League
7	War of the Holy League*
8	Austro-Turkish War*
9	Scottish War
10	Second Milanese War*
11	First War of Charles V*
12	Ottoman War*
13	Scottish War
14	Second War of Charles V*
15	Ottoman War*
16	Scottish War
17	Third War of Charles V*
18	Ottoman War*
19	Scottish War
20	Fourth War of Charles V*
21	Siege of Boulogne*
22	Arundel's Rebellion*
23	Ottoman War*
24	Fifth War of Charles V*
25	Austro-Turkish War*
26	Franco_Spanish War*
27	Scottish War*
28	Spanish-Turkish War*
29	First Huguenot War*
30	Austro-Turkish War*
31	Spanish-Turkish War*
32	Austro-Turkish War*
33	Spanish-Potuguese War
34	Polish-Turkish War
35	War of the Armada*
36	Austro-Polish War
37	War of the Three Henries*
38	Austro-Turkish War*
39	Franco-Savoian War
40	Spanish-Turkish War*
41	Austro-Venetian War
42	Spanish-Savoian War
43	Spanish-Venetian War
44	Spanish-Turkish War*
45	Polish-Turkish War
46	Thirty Year's War - Bohemian*
47	Thirty Year's War - Danish*
48	Thirty Year's War - Swedish*
49	Thirty Year's War - Swedish-French*
50	Spanish-Portuguese War
51	Turkish-Venetian War
52	Franco-Spanish War*
53	Scottish War
54	Anglo-Dutch Naval War*
55	Great Northern War*
56	English-Sopanish War*
57	Dutch-Portuguese War
58	Ottoman War*
59	Sweden-Bremen War
60	Anglo-Dutch Naval War*
61	Devolutionary War*
62	Dutch War of Louis XIV*
63	Turkish-Polish War
64	Russo-Turkish War
65	Ottoman War*
66	Franco-Spanish War*
67	War of the League of Augusburg*
68	Second Northern War*
69	War of the Spanish Succession*
70	Ottoman War
71	War of the Quadruple Alliance*
72	British-Spanish War*
73	War of the Polish Succession*
74	Ottoman War
75	War of the Austrian Succession*
76	Russo-Swedish War
77	Seven Years' War*
78	Russo-Turkish War
79	Confederation of Bar
80	War of the Bavarian Succession*
81	War of the American Revolution*
82	Ottoman War
83	Russo-Swedish War
84	French Revolutionary Wars*
85	Napoleonic Wars*
86	Russo-Turkish War
87	Russo-Swedish War
88	War of 1812
89	Neapolitan War
90	Franco-Spanish War
91	Navarino Bay
92	Russo-Turkish War
93	Austro-Sardinian War
94	First Schleswig-Holstein War
95	Roman Republic War
96	Crimean War*
97	Anglo-Persian War
98	War of Italian Unification*
99	Franco-Mexican War
100	Second Schleswig-Holstein War
101	Austro-Prussian War*
102	Franco-Prusssian War*
103	Russo-Turkish War
104	Sino-French War
105	Russo-Japanese War
106	Italo-Turkish War
107	World War I*
108	Russian Civil War*
109	Manchurian War
110	Italo-Ethiopian War
111	Sino-Japanese War
112	Russo-Japanese War*
113	World War II*
114	Russo-Finnish War
115	Korean War*
116	Russo-Hungarian War
117	Sinai War
118	Sino-Indian War
119	Vietnam War

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