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DIE EXPONENTIAL GESELLSCHAFT

Vom Ende des Wachstums zur Stabilisierung der Welt

Suhrkamp

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The Society of Exponentiality

From the End of Growth to Stabilising the World

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The greatest shortcoming of the human race is our inability to understand the exponential function.

Albert A. Bartlett

1

The rise of the society of exponentiality

My proposal of viewing today's global society as a society of exponentiality is founded on the observation that in the 21st century, exponential growth has come to shape central areas of society[1] to such an extent that not only is the continued existence of society in its current form under question, but its continued existence in any form. From the climate and environmental crisis, the pandemic, inflation, globalisation, migration, and mobility, all the way through to artificial intelligence, digitalisation, and ageing – many of the key developments of our time follow exponential patterns. What's more, through an intricately interwoven network of reciprocal relationships, seemingly unrelated fields turn out to be connected with one another. While earlier societies were characterised by recurring cycles or at most moderate transformations with limited consequences, today, we are undergoing a multitude of radical, simultaneous changes, which shape public debates and create new social conflicts.

But things can't go on like this for too long. The inevitable explosion numbers – be it greenhouse gas concentration levels, infection cases, or plastics in the ocean – that comes with this form of growth brings with it the threat of a disaster that would endanger our future survival. As such, stabilisation is the key organisational issue of our time. In central areas, exponential trends need to be interrupted early enough to induce stabilised conditions at levels that are sustainable and collectively desirable. Depending on the area in question, this may mean stabilisation at low levels (e.g. infection figures, CO2 emissions), high levels (e.g. information, technology) or medium levels (e.g. prosperity, temperatures). As we will see, society is increasingly thinking about possible paths in this direction and is arguing about possible stabilisation levels, implementation strategies, consequences, and side effects. The shift

from a growth-based society of exponentiality to a stabilised post-exponential society is obviously not going to be an easy one and will involve a great deal of debate. This book attempts to analyse and describe the role of exponential trends, the search for ways of achieving stabilisation, and the conflicts that arise out of this situation.

What is exponential growth?

Time and again, Al Bartlett described the "inability to understand the exponential function" as the "greatest shortcoming of the human race".[2] Which is why the American physicist, who passed away in 2013, spent his entire life as a researcher attempting to raise awareness of this phenomenon. And yet – apart from a few tricky little details – it's not actually that hard to get your head around. When people talk about exponential growth in everyday life, we usually think of particularly rapid growth. However, that is a misconception, because exponential growth can take place at both high and low speeds. Exponential growth occurs when the size of a particular variable increases by a constant factor over equal intervals of time, or, to put it more simply: exponential growth is characterised by consistent rates of growth. In contrast to linear growth, in which per unit of time a constant total quantity is added (an example being some stalagmites, which grow up from the floor of a cave from ceiling drippings, where the quantity of the mineral calcite being deposited per year might amount to 0.1 mm in height, a process that can go on over millennia),[3] exponential growth involves a constant percentage of change. This can be 0.1 per cent per year or 200 per cent per month – what matters is that the rate of change remains constant over an extended period of time (although, of course, a higher percentage leads to steeper increases, as we will see in a moment).

This central characteristic of constant rates of growth has dramatic effects: because the percentage always applies to the size of the variable that has already grown in the previous period, the absolute quantity of increase rises continually. To begin with, these increases are moderate, but at some point, the curve begins to shoot upwards, becoming steeper and steeper, the figures genuinely "exploding". And it is this violent change – despite the fact that the rate of change has stayed constant – that is the aspect that is so difficult to comprehend, which is what Bartlett was referring to with his statement.

Figures 1.1a and 1.1b illustrate the fundamental difference between linear and exponential growth using the example of a fictitious limestone cave.[4] A stalagmite growing at a linear rate, which at the outset measure just 1 millimetre and grows by 0.1 millimetre per year (which, as I mentioned, is actually a realistic order of magnitude), would reach the modest height of 1 metre after a period of 10,000. Meanwhile, a much more unrealistic stalagmite (unrealistic because it is growing exponentially), which grows 0.1 per cent per year, would have grown 22 metres over the same period of time. It is interesting to note that in this case, linear growth actually gets out of the blocks more quickly, as can be seen in the figures. Since the percentage of exponential growth initially applies to a very small variable, the progress is slow to start with (1 millimetre × 0.1 per cent = a 0.001 millimetre increase). At a certain point, however, the exponential process overtakes the linear progression, and eventually pulls ahead, mounting an unassailable lead. The discrepancy becomes even clearer if we posit an exponential growth rate that is twice as high. At 0.2 per cent growth per year, the curve shoots upwards much earlier. After 10,000 years, this magical rock would have reached the almost inconceivable height of 476 kilometres.

To give you a point of comparison, the International Space Station orbits the Earth at an altitude of around 400 kilometres (Figure 1.1b). As absurd as it might seem, our society today has virtually nothing in common with the real stalagmite and its linear growth, but instead resembles the exponentially growing turbo stalagmite.

Fig. 1.1a: Exponential versus linear growth

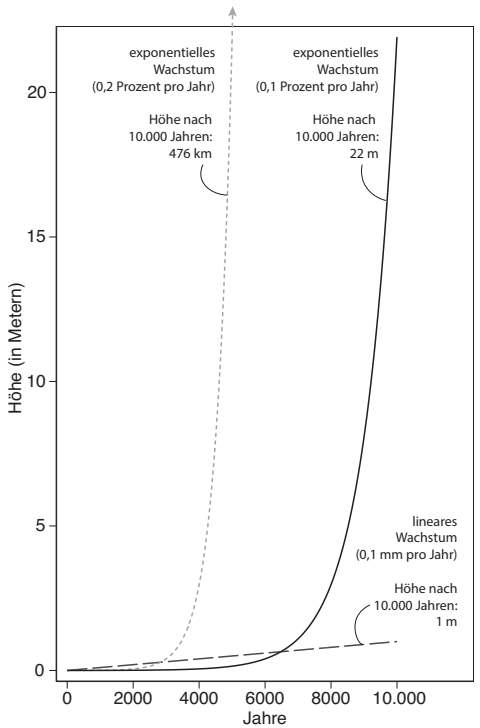

Image by the author. Inspired by Smil 2019, p. 12f.

Fig. 1.1b: Exponential versus linear growth

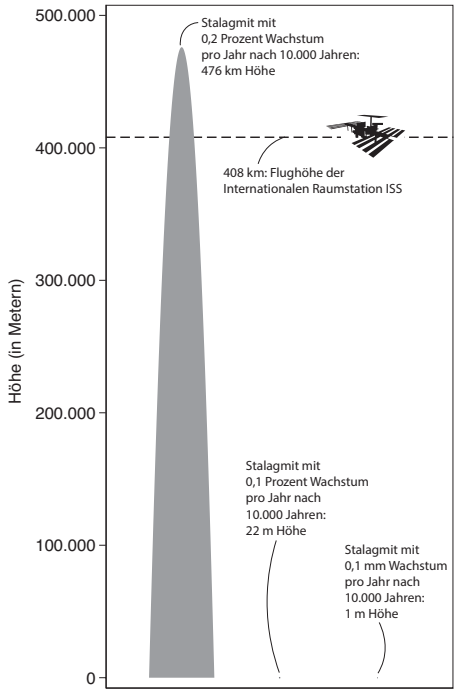

Image by the author. The ISS silhouette is symbolic and not depicted at a realistic scale.

The longer an exponential trend continues and the higher the growth rate, the steeper the curve becomes (with these two factors existing in an inverse relationship: the stalagmite growing at half the exponential rate will reach the dizzying height of 476 kilometres after double the length of time, so exactly 20,000 years). Because the real exponential trends analysed over the course of the book have varying lifespans and growth rates, some of the curves look slightly steeper or flatter than the others.

What's more, it's worth keeping in mind that even in the seemingly flat phase at the beginning, exponential growth is already present (as shown in Figure 1.1), and not only once the curve starts to rise up like a wall. And even if this book focuses predominantly on instances of exponential growth, I shall also discuss multiple examples of exponential decay (for example, through the decline in animal populations caused by environmental destruction). This is seen when there is a constant negative growth rate. In this case, the largest decrease occurs at the beginning, before the reduction then becomes smaller and smaller in absolute terms (because the constant rate of decline is being applied to an ever-smaller variable).

Another important point is that exponential growth can be displayed in two ways. Firstly, there is the "normal" mode of presentation, which is particularly well-suited to illustrating the substantial changes in the size of the variable. In this view, the steep increases are visible in all their radicality (see Figure1.1a). Secondly, there

Fig. 1.2: Log scale representation

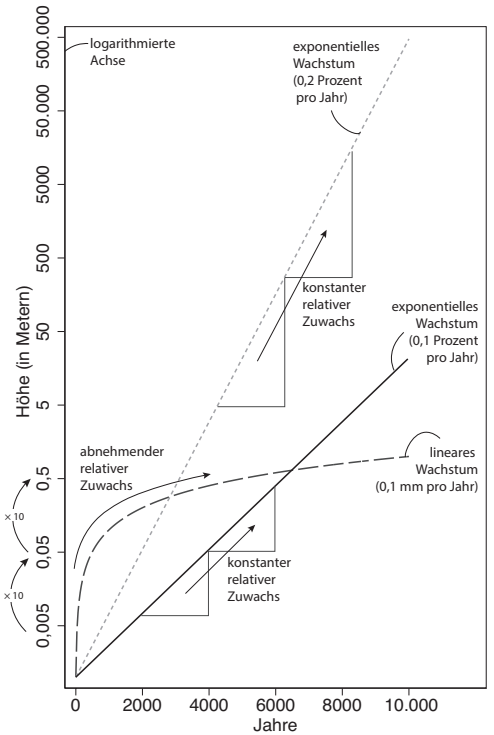

Image by the author.

is an alternative form of presentation where the vertical axis uses a logarithmic scale (Figure 1.2). The distance between two points on the Y-axis then no longer represents a fixed absolute difference (equal distances between 0, 1, 2, 3, 4 etc.), but a fixed ratio. For example, the distance between 5 and 50 is of the same ratio as that between 50 and 500, in this representing a tenfold increase in each instance. On this scale, if the growth rate is constant, the previously extremely steep rise turns into a straight line (from the bottom left to the top right in the case of positive exponential growth and from the top left to the bottom right for negative growth, with the incline increasing with the rate of growth). This advantage of this mode of representation is that you can see at a glance whether there is exponential growth (a straight line means yes). With the linear growth of the real stalagmite, this is obviously not the case, with its

curve in Figure 2.2. growing flatter and flatter, because the constant growth in absolute terms (1mm per year) represents an ever-smaller proportion of the total height in relative terms (in year 1 : 1 mm + 0.1 mm = a 10 per cent increase; in year 10,000 : 1 m + 0.1 mm = a 0.01 per cent increase). At the same time, the logarithmic representation has the disadvantage that the radical nature of the development, which an exponential trend brings in material terms, is not directly apparent,[5] as clearly visible in the representation in Figure 2.2. The absurdly high peak of the fastest of the exponentially rising stalagmite, at an altitude of almost 500 kilometres, is visually very close to that of the only one-metre-tall, linear stalagmite. Because these two modes of representation have both advantages and disadvantages, it is sometimes worth taking a comparative look at both.

Another aspect that should be taken into account is that in the case of real trends, the growth rate is generally not exactly constant, but only approximately so. Therefore, in the logarithmic representation, the line in the following illustrations will never be completely straight, but rather approximates a straight line. So as not to have to rely on the naked eye when we want to know whether an almost straight line with largely constant growth rates should be considered exponential or not, we can make recourse to statistical tests. In these tests, the empirical progression is compared with an ideal type of progression. A coefficient named R^2 is used to determine how well the two fit together ($R^2 = 0$: not at all, $R^2 = 1$: perfectly). In order not to avoid weighing this book down with statistical formulae, I have placed these values in the appendix. However, you can rest assured that all the empirical trends that will be analysed in this book can be described as exponential, with progressions that are very close to the ideal coefficients (with R2 values over 0.95 in almost all cases, and in most cases over 0.99). The appendix also includes an overview of the average annual growth rates and doubling times of the phenomena analysed. The doubling time refers to the length of time it takes for the variable being measured to double. Just like the growth rate, for exponential trends, this factor is constant, which is elucidated in more detail in the following info box “Technical Excursus”. But don’t worry, the content

of this book is easy to understand without making recourse to the formulae and figures in the box or in the appendix.

[…]

The characteristic properties of exponential growth take on a deceptive appearance in real, social processes (which is something I will come back to in Chapter 6): at the beginning of a development, exponential growth is often quite inconspicuous, and if the changes are noticed at all, they are typically viewed as constant progress (in the case of desired phenomena) or as nothing to worry about (in the case of unfavourable developments). For example, when a country sets itself the goal of growing the economy by 2 per cent per year, those setting this goal are hardly imagining an explosive trend, but rather a continual yet moderate increase in general prosperity. The situation is similar when it comes to the monetary policies of central banks. In the Eurozone, the target of 2 per cent inflation per year is known and accepted among the broader public. The figure is perceived as small, and in public discourse, it is often even viewed as a policy that keeps the currency stable (and at the same time create small incentives to spend money instead of stockpiling it. In this sense, it is generally not seen as a contradiction that one of the "primary objectives" of the European Central Bank (ECB) is to "ensure price stabilisation" while at the same time seeking to keep the inflation rate "below, but close to 2%".[6]

The focus is always placed on the growth rate, which is indeed constant and thus conveys an impression of stability. But this completely ignores the absolute quantity of the variable, which even at this stage is already growing exponentially – and at a rate ten times faster than the fastest stalagmite in Figure 1.1! It takes just 35 years for 2 per cent annual growth to double economic power, or for 2 per cent inflation to cause prices to double (see the information box "Technical Excursus"). But both processes remain largely unperceived by society as a whole. The medium-term development of the absolute figures of the variable in question scarcely receive any attention in the media, while the annual changes in the growth rate are always monitored with great excitement.

This often only changes when the exponential growth stops unexpectedly (for example if economic growth collapses or the inflation rate goes up) or – and this is the more interesting case in the context of this book – when the exponential trend continues to progress and reaches its "vertical" phase, in which the absolute values begin to shoot up in ever greater leaps. Of course, the term "vertical phase" is used here as a kind of shorthand, because structurally, nothing has changed, so it is not possible to identify a general point at which this phase has commenced. The point at which the trend is perceived as worthy of attention and disruptive depends entirely on the variable in question and on the person observing the trend. But whenever the vertical phase is reached in the subjective perception of the observer, the exploding figures of the variable suddenly begin to attract attention, because the consequences of the continually growing increases can no long be ignored as "constant" or interpreted as "stable. In the first example, it may be that the development of prosperity has reached a level at which large swathes of the populace are doing so well economically that their basic needs are adequately covered for, and a shift towards post-material values takes place. Or, that the side-effects of the spiralling consumption habits leads to ecological damage that becomes impossible to ignore. As such, the crux of exponential developments is that a tendency that has been present for quite some time but had not been particularly evident can suddenly have utterly different, sometimes grave and even extreme consequences, without the underlying pattern having changed at all structurally.

What is the society of exponentiality?

From my point of view, it makes sense to speak of a society of exponentiality if three key criteria are met: firstly, if multiple key areas of society are all strongly affected by exponential developments; secondly, if these developments are so advanced (in the "vertical" phase) that the massive changes in the absolute quantities of the variable take on a fundamental significance and come to challenge

the status quo – whether it's because they are triggering serious crises, threaten fundamental factors such as well-being, safety and security, or everyday coexistence, or perhaps even endanger the ecological foundations of life and thus the continued existence of human civilisation itself, or because they bring with them the potential for instigating social changes that can contribute to the solution of these very problems (examples here might be solar panels or scientific discoveries); and thirdly, if the exponential changes in the different spheres of society are not occurring independently of one another but are connected with one another via an intricately interwoven network of reciprocal relationships, that is, when exploding levels of the variable in one field have a direct or indirect influence on other spheres, which in turn exert an influence on still more spheres – a phenomenon I describe as a syndrome of exponentiality (more on this in Chapter 3).

Whether the society perceives the developments causing this pressure to transform and their constant grow rates as exponential, or ignores or denies this, is a secondary phenomenon. Often, the divergent approach to these developments by different sectors of society in public discourse becomes a central factor: the quagmire of differing and often contradictory reactions leads to new, important lines of conflict; with social, political and economic struggles increasingly revolving around finding answers to exponential shifts.

It is important to note that the society of exponentiality is a phenomenon that emerges only gradually. The three fundamental conditions I have just outlined cannot be simply ticked off as having been met or not, but can be present to varying degrees. The extent to which this definition applies depends on the amount of exponential developments occurring simultaneously in different spheres of society, the severity of the problems they trigger, and the level of intertwinement between them.

According to these criteria, it is patently evident that we currently live in a global society of exponentiality. Whether its the economy, ecology, the pandemic, knowledge, information, technology and digitalisation, mobility and communication, ageing, or

demographics, various spheres of society are marked by exponential trends. We will explore these in detail in the second chapter, but you can gain an initial impression from Figure 1.3, which shows exemplary trends that have progressed exponentially over durations of varying length, most of which are still progressing at an exponential rate: the rise in energy consumption, the rise in the money stock in circulation (here demonstrated by the M1 supply in Germany),[7] in anthropogenic mass (the amount of material embedded in buildings or transportation infrastructure produced by people), in the level of carbon dioxide in the atmosphere, in the cumulative number of COVID-19 infections at the start of the pandemic, in the number of international journeys, etc. – all these cases represent instances of exponential growth that in recent years have reached a steep, almost vertical phase.

For many of the more than eighty trends investigated in this book, this is happening without there being any kind of slowdown, intervention, let alone a stabilisation in sight. At the same time, the radical increases in the variables have become central social problems: deaths and long-term illnesses in the COVID-19 pandemic, economic crises and supply-chain issues, climate destruction and the resultant increase in frequency of flooding and droughts, rising rents and a lack of available housing caused by excessive tourism, and so on (more on this in Chapters 3 and 4). The ecological effects of climate change in particular represent an existential threat. If we do not manage to stabilise these trends, we threaten to slide into a "hothouse Earth", a hot period in which heating becomes self-reinforcing, and thus the end of civilisation as we know it.[8]

The third criteria is also fulfilled, because the various exponential processes – as wildly thrown together as the ensemble in Figure 1.3 might first seem – do not take place autonomously, but are linked via multiple interdependencies: the exponential economic growth promotes the various (deleterious) developments in the sphere of ecology, and is also partly responsible for the transfer of COVID-19 to human beings through the destruction of natural habitats. The global spread of the virus, in turn, was facilitated by

the exponential increase in cross-border mobility. The expansive monetary policy of many countries have fuelled economic growth for decades and was in turn fuelled by the pandemic. As in medicine, where the word "syndrome" has its origins as an expression for a combination of simultaneously occurring indicators of illness, here, too, it is not always easy to disentangle the causalities or to identify a clear origin. Nevertheless, in Chapter 3 I will attempt to present a systematic picture of the syndrome of exponentiality.

What holds this society of exponentiality together are not shared values or a feeling of connectedness, nor any multidirectional communication or interaction. You could describe the society of exponentiality as a Schicksalgemeinschaft (a community of shared destiny) if it weren't for the fact that it lacks the personal link to all people that the term "community" implies. So perhaps it is better characterised as a Schicksalgesellschaft (a society of shared destiny), in which a unity is formed purely through the fact that nobody can escape its consequences. Since no human being on this planet can completely isolate themselves from the problems of the society of exponentiality, this society of shared destiny is a global one. Since countless non-human beings (from corals to mangroves) are also affected, with their survival directly dependent on the stabilisation of exponential trends, they too belong to the society of exponentiality. The fact that the consequences and influences are unequally distributed – and this too is quasi-exponential (which I go into in Chapter 8) – does not detract from this. All living beings inhabiting the society of exponentiality society, regardless of how much agency they have, are subject to this exponentiality in one way or another. Nobody can entirely escape the dense network of long chains of interdependency.

As such, today's society of exponentiality is global, it is a society in the singular. At the same time, though, it continues to be heavily fragmented – spatially, politically, culturally, and socially. Communication and interaction networks, structures of power and governance remain limited in their reach. And this is an important point, because while the power of many exponential trends is unlimited, the question of their stabilisation is played out against the

backdrop of limitations in the ability of governing bodies to take action. And this touches upon the organisational dilemma that I will speak about in more depth in Chapter 7.

Development from previous forms of society

If it is true that today we live in a society of exponentiality, then we might logically ask how long this has been the case. Have there not always been exponential trends? In order to flesh out what is novel about our contemporary conjuncture, I will now attempt to contrast it with the past.

When dividing a historical development into epochs, the result is determined by the underlying criterion selected for the purpose. Karl Marx, for example, took forms of domination as the basis of his division, and distinguished between societies based on slavery, feudal societies, and bourgeois-capitalist societies – and a future, classless society. Since the central characteristic of the society of exponentiality is its specific form of growth, it seems appropriate to measure earlier epochs according to this very same criterion. If we do this, we can discern three previous phases of human history – and we can speculate about another, coming phase. First, we have a very long epoch of stagnation, second, there is the take off in the age of industrialisation, and third, the society of exponentiality, and fourth, a possible stabilised post-exponential society in the future.

Early human society, from its beginnings some 300,000 years ago up until the pre-industrial age of early modernity, was largely characterised by stagnation, cyclical ups and downs, and minimal rates of growth – if at all. For a very, very long time, the change in the seasons was the dominant pattern of change, at times perhaps the only pattern.[9] Tools and means of production remained constant from generation to generation. The vast majority of people were engaged in hunting and gathering, and later on in subsistence farming. Innovations were extremely rare, harvests were

Fig. 1.3: Examples of exponential develops of broad social relevance

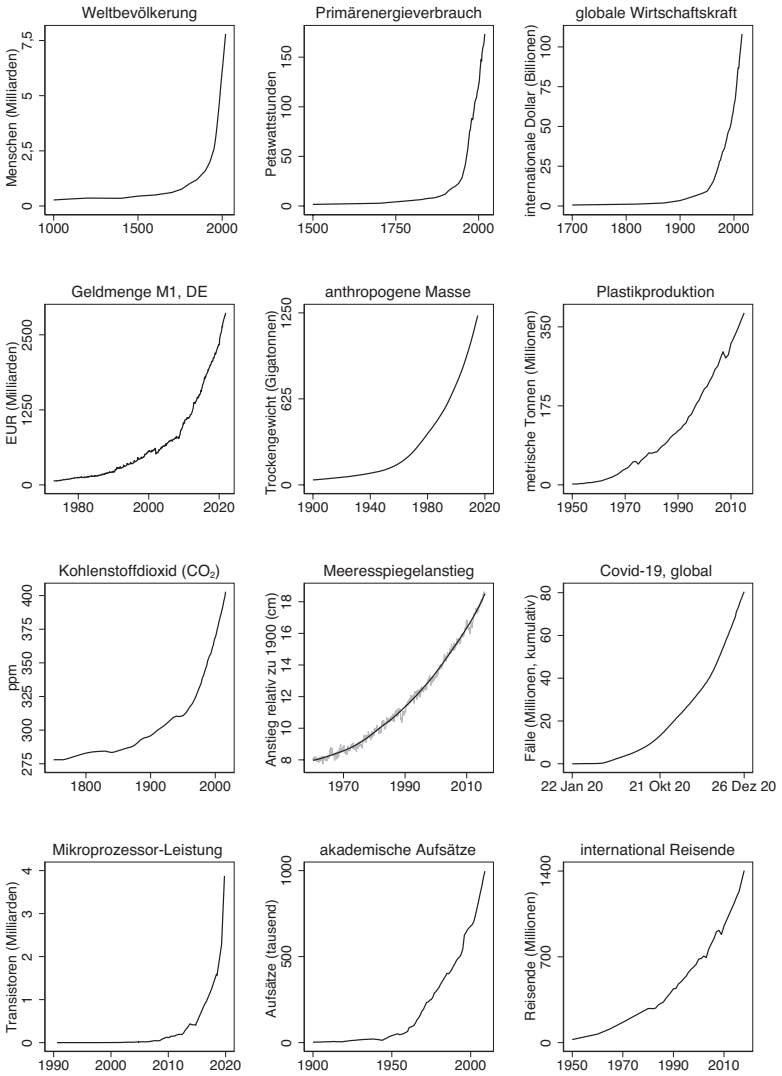

Image by the author based on data from Worldometer 2022; Smil 2017 and BP Statistical Review of World Energy via OWiD 2024a; figures before 1700 added from Smil 2008, p. 397, converting exajoules into petawatt hours by E. D.; OWiD 2022a (here, international dollars, converted to the value of 2011, thus removing distortions due to inflation); Trading Economics 2022; Elhacham et al. 2020; Geyer et al. 2017; EEA 2019; Dangendorf et al. 2019; Dong et al. 2020; Rupp 2020; Sinatra et al. 2015; UNWTO via OWiD 2019.

usually consumed immediately or used to secure survival, and was unable to be invested in increasing production.[10] As such, in this long first epoch of human history, economics was a "force of stasis, not of change".[11] Many other variables (from population and settlement sizes to life expectancy, livestock populations, and levels of prosperity) changed so slowly over millennia that growth can only be identified by condensing massive stretches of time.[12]

Of course, this does not mean that nothing happened. It would be inaccurate to view the past as an empty space devoid of events. There were indeed processes of expansion and accumulation in pre-modern times – especially from the beginning of the Neolithic revolution approximately 12,000 years ago, when humans began to cultivate arable land and erect larger buildings. The growth of the world's population, for example, can be described as exponential over several millennia leading up to industrialisation (of course, these are only estimates, as the further we go back into the past, the less accurate our data becomes) – even though the growth rate was much lower than after the industrial revolution (the pre-industrial doubling time was more than 800 years, but shrunk to less than 40 after the "take-off" era – see Chapter 2 and Appendix). In many spheres, there were regular reversals, phases of shrinkage, fluctuation, and, above all: stagnation. An example from the sphere of mobility is the speed of the delivery of post by land. Since no new forms of transportation were invented that were not reliant on muscle power, this was limited to 18 to 25 kilometres, which horses could comfortably cover without a break between two ideally positioned relay stations (where horses were changed). As far back as the time of Cyrus the Great (540 BCE), it was discovered in Persia that this distance was the most efficient compromise between maximising speed and an expensive overburdening of the animals, which meant that this relay system was maintained for thousands of years. As late as the 1860s, this system was still being used in the USA along the 3,000-kilometre route of the "Pony Express".[13]

This long, first phase of human history is also characterised by the fact that the populace saw material, technological, and economic conditions as immutable. They were under no illusions

that the future here on Earth would bring radical improvements in their living conditions. The historian Robert Heilbroner describes this phenomenon as "ubiquitous expectations of the impossibility of change", which he identified as a universal phenomenon among all cultures during the early phase of human history.[14]

It is easy to underestimate how long this first phase lasted. To illustrate just how long it lasted, the Dutch sociologists Hans van der Loo and Willem van Reijen suggest that we should look at the history of mankind as a day made up of 24 hours. If we do this, "we see that more than 23 hours of that day were spent in hunter-gatherer societies, agriculture and animal husbandry begin four minutes before midnight, urban civilisations emerge three minutes before midnight, and the birth of modern society […] occurs 30 seconds before midnight".[15] This means that stagnation and cyclical rhythms have almost always been the norm. From a historical perspective, long-lasting periods of global growth have been a major exception.

Things change (and this is precisely my point!) with the beginning of industrialisation in the 18th century. Driven by technological and scientific innovations, a shift occurred away from subsistence-based to accumulation-based forms of economic activity – namely capitalism.[16] While previously, the amount generated scarcely exceeded that which was being consumed, now, surplus value was being systematically extracted, which could then be invested, funding expansion, which in turn laid the foundations for further growth.[17] This established a self-reinforcing logic of constant growth, which is quite literally fuelled by the concentrated energy provided by fossil fuels.[18] This also leads to processes of differentiation and specialisation; more and more people are exchanging ever more specific goods, services, and information.[19] Acceleration becomes the central feature of industrialised society: trade, prosperity, population, mobility – suddenly, there are rapid increases in various spheres of society. And the rate at which new inventions are reshaping society is also increasing. But increasing rates of growth do not represent exponential change – the relative speed of change is not constant but increasing. And this makes sense, because in order to

go from a phase of stagnation (or very low growth rates) to a phase of consistently high growth, there first needs to be a transitional phase, in which the pace increases.

So in this take-off phase, we do not yet have of a society of exponentiality. There are certainly one or two long-lasting developments that seem to have maintained constant growth rates for centuries (the increasing quantity of books being produced will serve as an example in Chapter 2), but these tend to be isolated cases. And even when central trends (such as the growth of the global economy and population) ultimately approach their terminal, exponential velocity (typically between 1950 and 1970, see Chapter 2 on this as well), this growth is able to initially develop freely, as there is still plenty of space or other resources to accommodate this growth. So in the first instance, we are lacking the escalation (the "vertical phase"), along with the grave consequences that come with such growth. This does not mean that the take-off phase did not experience any problems or conflicts, on the contrary: the growth is sometimes accompanied by extreme forms of violence, in the instance of colonial expansion, exterminating indigenous communities, subjects human bodies to catastrophic working conditions in factories, and destroys the environment on a previously unseen scale. But these problems still mainly affect those who stand in the way of the machinery of acceleration or who are used as its fuel. Conflicts also escalate where the expansive drive of regional powers comes up against resistance from competitors who are equally spatially limited. Rising inequality is another negative by-product of growth, leading to greater social contrasts than ever before.[20] However, in the mid-20th century, the problems of the global dynamic of growth itself are still at most mere vague forms emerging on the horizon. The limitations of planetary resources are (seemingly) still miles away, the streets are empty, the skies clear. The issue of stabilisation has not yet arisen. On the contrary, society is occupied by entirely different questions, such as how to expand the gains in prosperity and knowledge such that broader sections of the populace are able to benefit from them; how to tackle growing inequalities or how this progress can be expanded and made permanent.

The engine is finally up and running, and nothing could seem more unnatural than to suddenly switch it off. There are substantial increases according to multiple indicators: such as prosperity, health, and literacy. With each passing generation and even within individual lifetimes, everyday life becomes noticeably more pleasant. And this leads to a correspondingly positive view of the future within the society. The expectation of immutability that previously prevailed has made way for a belief in progress – at least in those parts of the world (and in the social classes) that benefit most from this growth.[21] Previously unimaginable possibilities emerge; suddenly, it seems as if nature can be controlled, and these increased forms of agency lead humanity to see itself as the master of its own destiny. Parents work hard to ensure that their children will have it better than they did – an expectation that was realistic at the time. History is made, everything is moving ahead.

Another major shift occurs when ever more exponential trends in a whole host of spheres become more dramatic, causing the absolute numbers of the variables to trigger serious social problems. Because not all of the trends reach their constant rate of growth at exactly the same time and this process is, as mentioned above, a gradual ramping up, it is not easy to identify a particular starting point. What is clear, however, is that in the 1960s and 1970s many central trends reached their "final", exponential velocity, which made indicators of the coming escalation visible, which were then recognised and discussed within society at large. Since 1970, the annual use of resources has exceeded the amount that is actually available (which I discuss in more detail in Chapter 4), and animal populations also began shrinking at this time (see Chapter 2). Particularly in The Limits to Growth, the famous report issued by the Club of Rome in 1972, urgent attention was drawn to these exponential developments and their catastrophic consequences (more on this in Chapter 4). However, despite receiving broad acknowledgment, these early warnings largely petered out without leading to any major consequences, and in 1988, the concentration of CO2 in the atmosphere sails past its planetary limits (levels that would be sustainable for the planet) – an exponential trend that

continues unabated to this day. We could also say that it is only because the early warning did not lead to a concerted shift in behaviour that today we are living in a society of exponentiality, with all the fraught problems this brings with it. What is certain, though, is that since 2019 at the latest, when the worldwide mass demonstrations of the climate movement reached their (preliminary?) peak and SARS-CoV-2 arrived on the world stage, dramatic exponential trends and the social crises they trigger have been omnipresent.

And if perceptions of growth processes had not shifted before, they are certainly changing now: what was just a moment ago viewed as a welcome increase in prosperity has suddenly come to be seen as a major planetary risk. The automobile is no longer a freedom-generating status symbol of the upwardly mobile middle classes but for many, an emblem of inconsiderate selfishness in a world on the brink of ecological collapse. The aeroplane, until recently a proud engineering achievement and facilitator of a connection with the world, is now the vehicle of deadly cirrus clouds, greenhouse gases, and virus particles. The word "growth" has lost its lustre and has become ambivalent, as has the future itself. As Robert Heilbroner states, drivers of change now have positive and negative connotations.[22] They seem threatening and comforting at the same time, or, as philosopher Nick Bostrom has put it, "as promising as they are fragile, dangerous, and ominous".[23]

What is new about the society of exponentiality is therefore not the presence of individual exponential trends, because these undoubtedly existed in earlier times. In addition to the aforementioned pre-industrial examples of population growth or the exponential increase in book production since the invention of the printing press in the 15th century, we might also think of the Dutch Tulip Mania of 1637, when the bulbs of these flowers became an object of financial speculation and their price rose exponentially over a very short time. Or of the Great Plague, when the plague spread throughout London at an exponential rate between May and September of 1665, leading to the death of 20 percent of the population of the city. Perhaps it would make sense to view the Netherlands and England during these phases as geographically and temporally deli-

neated "societies of exponentiality". However, today's situation is fundamentally different from such historical examples. While such earlier exponential developments (such as pre-industrial increases in population and book production) were either very slow and did not reach a crisis-inducing "vertical phase (at the time) or only emerged in isolation and attracted the attention of society on their own for a relatively short stretch of time ("just" the skyrocketing prices of tulips during Tulip Mania, "just" the health of the population of London during the Great Plague, today, a multiplicity of interlinked exponential trends in various spheres of society are causing fundamental problems with global effects. This intensification in multiple societal spheres and the novel, interconnected nature of global society produces an entirely different degree of fragility. Problems in one area can have – direct or indirect – impacts on others. In a spatial sense as well, far-reaching chain reactions can emerge in all directions, known as ripple effects, increasing systemic risks.[24] We are constantly faced with looming crises: global warming, pandemics, economic collapse, scarcity of resources. At the outset, the society of exponentiality soared to lofty heights. Now, it threatens to crash to earth unceremoniously. Which raises the question of how to proceed.

As we will see in Chapter 4, in each of the areas analysed, the issue of stabilisation must be addressed. If we wish to prevent an uncontrolled expansion of negative consequences, these trends must be arrested before it's too late, keeping numbers of the variables in question to a level that is desirable for society at large. If we were to achieve this across the various spheres, we could speak of a stabilised post-exponential society. However, this potential fourth phase of human history, is only one among several conceivable scenarios. Another potential future is that of uncontrolled disaster.[25] In this case, exponential trends would continue until they cause a collapse – as described above, with catastrophic consequences. This might occur because stabilisation efforts are carried out in a half-hearted manner, because other, more urgent-seeming, short-term problems (such as wars) attract all our attention, or because the processes increasingly become self-perpetuating, making it impossible to intervene.

In any case, the stabilised post-exponential society forms the vanishing point of this book, as it were: a society that has reached a capacity for stabilisation that allows it to intervene in exponential processes for the benefit of all – including for future generations – redirecting these developments into manageable proportions. Such a society would create the preconditions for securing a sustainable and socially just society over longer periods of time. That might sound utopian, but from my point of view, it is conceivable and potentially realisable. The uncontrolled collapse would be the dystopian counterpart to this vision. Between utopia and dystopia there is a broad spectrum of possible futures. The only thing that seems increasingly unimaginable is continuing on our current exponential path.

Sociology as a matter of form

If you go looking for books on exponential trends, the main thing you find is guidebooks on how to profit personally from exponential growth: "Future-proof Yourself and Your Business in the Age of Exponential Disruption" is the subtitle of one of these books.[26] Others recount of the huge profit potential of "exponential innovations".[27] One religious book even speaks of a "future-proof faith in an age of exponential change".[28] What all these titles have in common is that they approach the topic from a particularistic angle: How can I profit from exponential growth? They all frame exponentiality as a personal opportunity, never as a systemic threat.

The approach of this book is quite obviously a different one. It seeks to look at the big picture. Such a perspective also involves framing the environment in which social life is embedded as an essential component of the analysis. If we want to understand society, we cannot exclude ecological questions, especially not today. That might sound obvious, but for a long time, when it came to environmental issues, there was a prevailing "sociological abstinence", as Niklas Luhmann noted.[29] "Climate change,

the most pressing problem of this century, is scarcely addressed by sociology", wrote fellow sociologist Andreas Diekmann as recently ago as 2024.[30]

By taking into account social, economic, technological, energy-related, demographic, political, psychological, and ecological processes, I hope to gain an enhanced understanding of the situation – including prognostic thinking about possible stabilised futures and strategies for how to get there. This inclusion of natural conditions brings us into proximity with the sociology of Bruno Latour and others, who view ecological and technical artefacts, non-human beings, and "more-than-human collaborations" in a more general sense as social actors.[31] When, in the following chapters, I explore phenomena such as carbon dioxide molecules accumulating in the atmosphere, transistors crowding onto microprocessors, viruses multiplying, or shipping containers travelling around the world – all of which follow an exponential pattern of increase – I do so because there is a great deal of evidence to suggest that Latour and co. are right: all these things are of the utmost sociological relevance. The form in which all these things are developing is characteristic of the society of exponentiality.

And form is am important term here, because another point of reference for this book is the "formal sociology" outlined by Georg Simmel. At the turn of the 20th century, the German sociologist argued that whereas other disciplines had a set sphere of inquiry, which they investigated at the level of content (legal studies with laws and judicial decisions, political science with political relations, etc.), sociology dealt with the forms of coexistence rather than with their concrete content. For Simmel, however, "formal" does not refer to mere formalities or official narratives but looks at social forms, structures, patterns. He names cooperation and conflict as examples of such social forms. Sociology can look at conflict in utterly different contexts: between lovers, coalition partners, or between armed parties in a civil war. All of these cases bear structural commonalities that make it meaningful to address them collectively on a higher, abstract plane.

What I would like to propose here is developing Simmel's notion into a formal sociology in a literal sense, one that makes recourse to actual geometrical forms and not just social ones, which in truth are more akin to concepts. But in Simmel's work, we can already find an example of the use of such a geometrical form in his famous intersection of social circles (in an eponymous chapter in one of his books, he described the social position of a person as the unique point of intersection of various circles – elegantly revealing the simultaneity of individuality and social ties).[32] Geometrical contours also often play an important role in current sociological debates. For example, when discussing whether unequal distributions of wealth resemble the silhouette of an elephant or whether opinion patterns are best represented by the one-humped form of a dromedary or the polarised, two-humped shape of a camel.[33] Taking this further, it would be possible to generalise these examples and conceive of a "geometrical sociology" that systematically investigates the socio-geometric patterns behind aggregated societal structures.[34] The specific socio-geometric form that comprises the focus of this book is the exponential curve. Following Simmel's initial impulse, it is not a question of a specific exponential curve in a concrete thematic field, but about the fact that exponential curves that follow the same underlying mechanisms (more on this in Chapter 3) have become important in utterly different spheres. Taking a detailed look at this recurring structure can help us to better understand society. Sociology becomes a matter of forms.

A formal sociology in this literal sense requires a high degree of abstraction, which has advantages and disadvantages. One of the disadvantages is that subtle details become blurred that would remain visible in specialised studies. What's more, there is a danger of excessively reducing things to a one-size-fits-all model of explanation: if the only tool you have is a hammer, as the saying goes, everything starts to look like a nail. Applied to our object of study here, this would mean finding exponential curves everywhere we look, because that is what we are looking for, and ignoring other developments that do not fit the mould. Ultimately, though, that is not a problem. Because this book does not assert that all con-

temporary social developments are exponential in nature, but that a certain number of them are, and that their relevance as a whole is difficult to dispute. As such, if you wanted to refute the thesis of the society of exponentiality, it would not suffice to find developments that are not progressing exponentially. You would need to prove that the exponential trends I am describing here do not significantly determined the contours of our society. In addition, this book argues that there is in fact no need for there to be ubiquitous exponential growth, and that interruption and stabilisation are just as possible (Chapters 4 and 5).

Conversely, one of the advantages of employing such an approach is that it identifies things that only become apparent by looking at the big picture. If you concentrate on one form, you can uncover similarities and differences by converting seemingly unrelated phenomena into comparable units (in this case: growth rates and doubling times). This "universalising force" is already an important idea in Simmel's work and in my view, also highly valuable in our context.

Structure of the book

The remainder of this book is divided up into eight chapters. In the second chapter, I comb through six central spheres of society (based on extensive data), in order to illustrate how influential exponential developments are today: (1) economics, (2) ecology, (3) pandemics, (4) information & technology, (5) mobility & communication, and (6) demographics. The spectrum of influence ranges from global refuse production and artificial intelligence to the risk of developing diabetes or suffering a stroke over the course of one's life. This also illustrates why these tendencies are increasingly shaping social debates and posing new problems.

Building upon this empirical basis, in the third chapter I take a closer look at a number of the characteristics of the society of exponentiality, constructing a theoretical framework for these particularities. Firstly, I sketch out the more-brings-more mechanism behind virtually all exponential trends: growth in the variable size in absolute terms creates the foundation for further growth. I then attempt to untangle the complex interactions between these exponential trends a little. In doing so, it becomes clear that these are not disparate individual phenomena but a large network of causal relationships – what I refer to at the syndrome of exponentiality. It also becomes evident that from an individual perspective, there is an interest to engage in actions that fuel further growth, while from a collective perspective, stabilisation would be desirable – a fraught situation, as is typical for problems of the collective good. And then there are the fault lines within the society of exponentiality, which divide people into milieus with different interests and values. A series of new social conflicts emerges, ignited precisely by the issue of how we deal with exponential trends. I identify condensed chains of interdependency as one of the causes of this increase in social conflict: much more than was previously the case, every action is caught up in a tightly woven net of reciprocal relationships- This leads to a situation in which the society of exponentiality becomes an "annoying fact" for many, to borrow a phrase from the British-German sociologist Ralf Dahrendorf.

The fourth chapter looks at the theme of stabilisation. Why is it necessary, and what might it look like in concrete terms? I answer this question for the six spheres of society that structured Chapter 2. In the field of ecology, for example, what is required is an effective form of Earth system stewardship, which leads us back to the sustainable path of a "stabilised Earth". In terms of pandemics, it is a matter of stabilising infection figures and deaths to the lowest level possible; in the field of science and technology, it is a matter of drawing ethical and legal boundaries (when it comes to AI, for example, or biomedical technology such as cloning); in the field of mobility, it is a matter of limiting the production of greenhouse gases, air pollution, and noise, and avoiding excess energy and material usage, and ensuring that space shortages are not created in limited urban areas, for example. Looking at the big picture, it becomes clear that the problem of stabilisation is of great urgency in all the spheres of society discussed here.

In the fifth chapter, I argue that this kind of stabilisation is indeed possible. Among other things, I show that we can already observe multiple instances of exponential growth transitioning to stable situations. By way of numerous examples – from saturation processes with respect to the distribution of mobile phones (stabilisations at a high level), to the historical development of global CFC production (stabilisation at a low level) and the development of share prices after the dotcom bubble (stabilisation at a medium level) – I illustrate that stabilisation is omnipresent in three ideal types. This makes it clear that exponential growth is generally only a phase. There is no reason why this should not also apply to the "big" exponential trends of our time. But stabilisation is also always fragile, it does not automatically materialise in the desired form, and there is no guarantee that it will be maintained in the long term. We may have to fight hard to bring it about and shore it up with regulative measures.

The sixth chapter deals with the question of why, from a psychological point of view, people are relatively poorly prepared for life in a society of exponentiality. There are a whole range of mechanisms that contribute to this: difficulties making sense of numbers, repression, a lack of information or the existence of false information, the failure to consider the future, habit, and the phenomenon of shifting baselines. Taken together, these factors explain why, in our dramatic, threatening reality, it is not easy to come up with constructive solutions, even though in principle, we know what needs to be done. However, we can find hope in the fact that as a society, we are able to establish institutional mechanisms that outfox our biases. In addition, under certain circumstances, people get swept up by social dynamics, meaning that the power of exponentiality can theoretically also be used for the purpose of mobilising for the cause of stabilisation.

It is precisely at this point that the seventh chapter picks up, first of all describing the fundamental political conflict of the society of exponentiality, which is played out between expansionist and stabilising forces. The former are interested in further growth, the latter in its cessation. In order to illustrate how the stabilising

side can take action despite the unfavourable power asymmetry that exists, I sketch out a triangle of stabilisation capacity. This diagram demonstrates how, when combined with one another, individual action, collective controls, and technological and scientific solutions can develop the potential to tackle exponential problems. In addition to fostering this stabilisation capacity, it is also necessary to refute expansionist ideologies. To this end, I illustrate that four popular expansionist visions (continuing on our current expansionist path, green expansionism, ad-astra expansionism, and metaverse expansionism) can quite easily be unmasked as castles in the air.

The eighth chapter situates the thesis of the book within a broader sociological framework. To begin with, I explain how my viewpoint differs from three established diagnoses of society: Ulrich Beck's risk society, the acceleration society of Hartmut Rosa, and the society of singularities as outlined by Andreas Reckwitz. While in the risk society, for example, incalculable risks hover above society menacingly (which can occur in the next instant, in ten years, or never), the constant growth rate of exponential trends makes their consequences quite easy to calculate – which I refer to as the new calculability. I then go on to show that many goods (income, wealth, energy consumption, etc.) in the society of exponentiality are themselves unevenly distributed in an exponential fashion – a kind of exponentiality behind the exponentiality, a phenomenon that has interesting consequences. Finally, I offer another reason why the concept of the "society of exponentiality" might be useful: namely that because it operates at a level of abstraction that is slightly higher than most diagnoses of society, it creates a unifying bracket within which important issues that are typically viewed separately (the climate crisis, pandemics, economics, species extinction, globalisation, AI, etc.) can be analysed collectively.

Following on from this triad of psychology, politics, and sociology, in the concluding, ninth chapter, I sum up my argument and offer a perspective of the future. In an invitation to engage in non-linear thinking, I first make an appeal to consider the exponential logic of change, but without seeing the future as an inevitable continua-

tion of exponential paths, but as a space of possible for sustainable shifts in direction. I then outline what is socially necessary for this to occur: a raised awareness and understanding of exponentiality, making tipping points of exponential growth visible, fostering our capacity for stabilisation and increasing the attractiveness of stable conditions. And finally, I consider the knowledge gleaned in this study against the backdrop of the Gaia and Medea hypotheses, which view life as either self-stabilising or self-destructive, due to a postulated predominance of negative or positive feedback loops. I counter these two hypotheses with the Janus hypothesis, which holds that both things occur simultaneously: on the one side, self-reinforcing exponential trends threaten life on this planet, while on the other side, society responds to this situation, actively working to redress it. As such, this book ultimately positions itself between overly optimistic viewpoints on the one hand, which assert that things are always getting better, and overly pessimistic diagnoses, which maintain that the only option left to us is to resign ourselves to the inevitable catastrophe. Whether we will see an unregulated collapse or a targeted stabilisation at sustainable levels that are desirable for human well-being is well and truly yet to be decided. The future is something that we actively shape, despite massive resistance and closing windows. With this book, I am attempting to show where we stand and just how much is at stake.

Endnotes

1 I am deliberately avoiding terms such as "field" or "partial system" here, as used by the sociologists Pierre Bourdieu and Niklas Luhman, because I want to retain a certain analytic flexibility, and also capture aspects such as demography, which predominantly relates to the social structure.
2 Bartlett 2004; and similarly, Bartlett 1976, p. 395.
3 Smil 2019, p. 12. Depending on the conditions in the cave (drip rate, temperature, calcium concentration), the rate of growth per year can be lower or higher (there are stalagmites that grow one millimetre per year), but for the stalagmites, the local conditions are typically constant over the longer term (Culver and White 2005, p. 545).
4 I took the idea for this example from Vaclav Smil's brilliant book Growth (2019, p. 12 f.).
5 On this, see also Chapter 9.
6 ECB 2021; here, the second sentence comes just two paragraphs after the first one, without any discussion of a logical contradiction between the two.
7 M1 money supply comprises only physical currency and demand deposits, that is, bank balances that can be withdrawn at any time (or can be used for cashless payments), making it a relatively narrow definition of money.
8 Biermann et al. 2012; Steffen et al. 2018; Waring et al. 2024.
9 Sinclair 2019, p. 217; see also Bourdieu 1993a, p. 386.
10 Smil 2019, p. xi; Keynes 2024 [1930], p. 9.
11 Heilbroner 1996, p. 8.
12 Smil 2019, p. xi.
13 Ibid., p. xii; Minetti 2003.
14 Heilbroner 1996, p. 8.
15 Van der Loo and van Reijen 1997, p. 12; see also Nolan and Lenski 2008, p. 67; Bostrom 2018, p. 21; as well as Gates 2021, p. 166 : "During 99.9% of human history, we got from A to B entirely without recourse to fossil fuels."
16 Greenfield 2009, p. 402; Heilbroner 1996, p. 10. Keynes (2024 [1930], p. 10) situates the start of capital accumulation (which for him is the beginning of modernity) at an earlier date, namely in the 16th century.
17 Marx (2003a [1849], p. 387) provides a striking description of the resulting "accelerated movement of the growth".
18 Pfister 2020.
19 Lenski 1966, p. 204.
20 See, for example, Kerbo 2011.
21 Heilbroner 1996, p. 11.
22 Ibid., p. 13.
23 Bostrom 2018, p. 18; Folkers 2022, p. 240.
24 Helbling 2013; Centeno et al. 2015.
25 See also Urry 2008.
26 Sanei 2017.
27 Espindola and Wright 2021; Wadhwa et al. 2020.
28 Cole 2018, p. xxi.
29 Luhmann 2008 [1986], p. 9.

30 Diekmann 2024, p. 3

31 Folkers and Opitz 2020; Haraway 2018; Hoppe et al. 2023; Latour 2017 [2015], 2018.

32 Simmel 1992 [1908], pp. 456–511.

33 Milanovic 2016; Mau et al. 2023.

34 The concept "geometrical sociology" appears for the first time in a short essay from the year 1902. In this text, the author R. Wolf-Wolfenau, about which little is known, describes how hustle and bustle takes place on a market square in which various social groups stroll about at either end, but only come into contact here and there in the middle (Wolf-Wolfenau 1902). In 1973, the American cultural sociologist used the term to characterise the sociology of Simmel (Davis 1973). In my own previous works, I have investigated another specific form, the power-law curve, which likewise appears in radically different contexts (Deutschmann 2016a, 2016b). A power-law curve describes a particular, extremely marked unequal distribution, which become straight lines when both axes are drawn on a log scale.