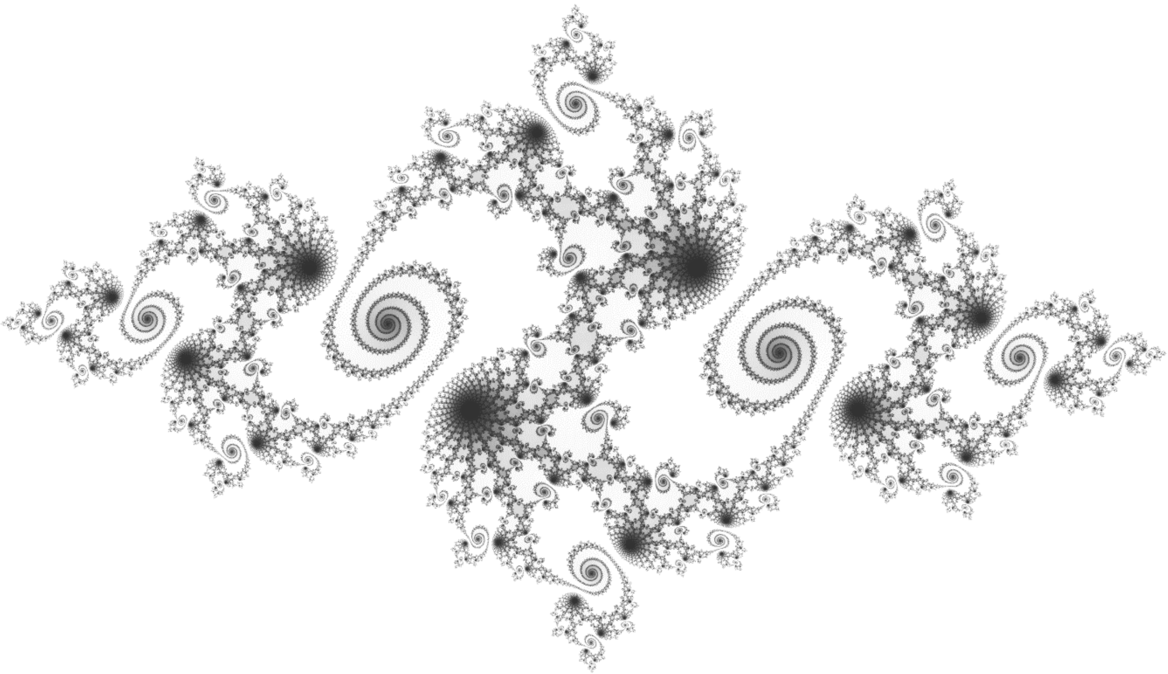
Public Policy as an Art

Perspectives from Complexity Theory and Uncertainty Management



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Preface

If you would have told the high school version of me that he would end up in an intensive small-scale research master, studying philosophy and economics and finishing with a thesis writing project that is supposed to take roughly half a year, I am pretty certain he would not have believed you (and would likely have laughed at you). Yet, here is my thesis.

The path from high school to this very moment has been influenced by many factors. Without those, I would not have been where I am now, and this thesis would not have been the same (or would not have been written at all), for which I would like to express my gratitude.

Thanks to the authors who made me realize that thinking critically and philosophically about economics can be a fascinating thing to do—and not only that, it can even be useful. Particular thanks are due to Tomáš Sedláček, Daniel Kahneman, Amartya Sen, and Nassim Nicholas Taleb.

Thanks are due to the whole EIPE community, though particular thanks are due to my supervisor Jack Vromen, whose advice and comments are always helpful and to the point. Comments from my advisor Roger Backhouse were very valuable in improving and clarifying my thesis. Also, I have always very much appreciated the open atmosphere at EIPE, which allowed and stimulated me to engage in non-mainstream ideas. Then thanks to my fellow students and friends—in particular to Öykü with whom I had many breaks, discussions, and misunderstandings, but also to Manon, Hidde, Lennart, Lieke, and Piet for good company and interesting discussions and conversations. Thanks also to Vincent for his comments.

Randomness has influenced the path from high school to this very moment as well, but I am unsure how to express my gratitude for that.

Lastly, both thanks and apologies are due to my family and friends. The thanks are for everything, the apologies are for me having taken up too many things to be able to free up the time I would have liked to spend with them.

What's next? An open future, a sabbatical of to-be-determined length from academia, a time for new discoveries (and old pleasures)—an uncertain mix of entrepreneurial attempts, philosophical musings, literary pastime, musical escapades, and whichever good (and bad) things will cross my path.

Lastly, I would like to express the hope that you, reader, will find this thesis an interesting (and convincing) read.

—Anne Albert

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CHAPTER 1

THE ART OF ECONOMICS

Once the complexity of reality is carefully considered, the argument that applied policy concerns can be reduced to economics becomes so unreasonable that only an academic would dare consider it.
—J.N. Keynes

1.1 Introduction

More than two millennia before Adam Smith published his *Wealth of Nations* (1776), the Greek philosopher Xenophon published two books on what can be called economics: *Oeconomicus*, a discussion of good household management,[1] and *De vectigalibus*, which translates to *On revenues*, which consists of advice on how Athens might increase the revenues of the state and increase the prosperity of the city (Sedláček, 2011). Hence, Xenophon may be characterized as one of the first economic policy advisors. Nevertheless, most economic thinking in ancient Greece focused on the ethics of economic activity, a line of thinking that remained prominent well into the Dark Ages until it gradually gave way for a focus on how the economy in fact works (Backhouse, 2002). This focus on how the economy works, however, was not so much motivated by a genuine curiosity into the workings of the economy than by an interest in policy making: in seventeenth-century England, for instance, writers on economic subjects did so in the context of advocating or arguing against certain policies (though their ways of arguing were often inspired by scientific methods). Similarly, in eighteenth-century France economic writing revolved around reforms. More generally, classical political economists—amongst whom Smith, Ricardo, Mill, and Marx—were always closely involved in policy making or discussions about policy making.

Despite economics becoming increasingly technical and mathematical in the aftermath of the Second World War, policy making remained an important aspect of economics (Backhouse, 2002). At least in part due to the important role that economists played in decision- and policy making during the Second World War, economists continued to be important in policy discussions. For instance, in both the United Kingdom and the United States the role of economists in policy making became institutionalized in Government Economic Service and the Council of Economic Advisors, respectively. However, their influence was not too big and varied over time. Moreover, an increasingly prominent view held that economics had a theoretical core that could be applied to different issues, hence providing a more or less unified and clear foundation for applied economics.

[1] Or, more precisely, a discussion on how to manage an agricultural estate (Backhouse, 2002)

However, following a line of argument defended by John Neville Keynes in *The Scope and Method of Political Economy* (1891), Colander (2001) criticizes this notion of economics having a theoretical core that can be applied to various problems. His criticism is based on the idea that economics should be divided in three categories, namely positive economics, normative economics, and the art of economics. Behind this tripartite division is the idea that we have positive economics for investigating how the economy in fact works, normative economics for discussing what economic goals a society (or perhaps an individual) should adopt, and the art of economics for formulating practical precepts that can be used to reach certain goals (e.g. those formulated in normative economics). Arguably as a result of viewing economics as having a theoretical core, many current economists who are doing applied work use methodologies from positive economics that are ill-suited for applied work. Keynes already warned for this lack of awareness of the separate status of the art of economics (which was also present in his days), deeming it “the source of many mischievous errors” (1891, p. 35). Colander (2001) argues that in contemporary economics, not viewing the art of economics as separate from positive or normative economics harms the whole of economics. Not only is applied economics ignored, both positive and normative economics are expected to achieve a practical relevance that it simply is not well suited to do. Hence, Colander argues, the art of economics should gain a much more prominent place than it currently has (in so far it has a place at all in contemporary economics).

This thesis presents and discusses two perspectives on public policy that, implicitly or explicitly, agree with the idea that public policy should be regarded as an art, not a science. The first perspective comes from a book by David Colander and Roland Kupers (2014), *Complexity and the Art of Public Policy*, in which they present a so-called complexity frame for public policy. This complexity frame, as the name indicates, is based on complexity science (and complexity economics in particular) but recognizes that science alone cannot be a proper foundation for policy making. The second perspective is based on the work of Nassim Taleb (in particular Taleb, 2010; 2012) discussing and advocating his approach to what this thesis labels uncertainty management. In general, Taleb argues in favor of using non-predictive methods and heuristics in the face of extreme forms of uncertainty which, he claims, is what we (mostly) face in socioeconomic systems. In contrast to Colander and Kupers, Taleb does not explicitly engage with the idea that public policy should be perceived as an art. Nevertheless, we will see that his work fits well with this idea.

The aim of this thesis, then, is twofold. One goal is to connect Taleb’s work to the complexity tradition, in particular in the context of public policy. This goal is motivated by Taleb’s work seemingly having some commonalities with the complexity way of thinking. To the best of my knowledge, such connections between Taleb’s work and complexity thinking have remained (largely) unexplored, hence this is a worthwhile undertaking. The second, more overarching aim of this thesis is to discuss how those two perspectives exemplify how public policy perceived as an art could (and, to some extent, should) be instantiated. To achieve those aims, this thesis is organized as follows. This introductory chapter continues by discussing what ‘the art of economics’ is (section 1.2), after which it offers some further historical perspectives on the relation between economics and public policy (section 1.3). Section 1.4 then discusses the relevance of (the art of) public policy and suggests some reasons for why thinking of public policy as an art is particularly relevant now—and increasingly so.

The second and third chapter present the perspectives based on Colander and Kupers (2014) and the work of Nassim Taleb, respectively. Chapter two will also spend some words on Kirman's (2016) perspective on public policy. The fourth chapter draws connections between both perspectives and identifies (dis)agreements and complementarities. The fifth chapter contains a critical discussion of both perspectives. The sixth chapter discusses how both perspectives view the relation between practice and argues that both perspectives are examples of how the notion of public policy as an art can be instantiated. The concluding chapter summarizes and offers some afterthoughts.

1.2 What is the Art of Economics?

The basic difference between the art of economics and the science of positive economics is that whereas the former focuses on the real world (hence on dealing with practical problems, making real-world decisions, and trying to achieve particular real-world goals), the latter focuses on matters abstract and intellectual. In other words, the art of economics is concerned with *doing*, the science of positive economics is concerned with *understanding*. The reason that those two need to be separated is that understanding does not necessarily make one a better decision maker or better practical problem solver—and particularly so in the context of so-called complex evolving systems and fat-tailed uncertainty. Why this is the case (hopefully) becomes clear throughout this thesis. Given this distinction, we can get a bit more precise about what the art of economics is all about.

We already noted that what John Neville Keynes meant with the art of economics was formulating practical precepts for reaching certain stated goals (1891). Regarding this, Keynes distinguished between two interpretations, one being that the art of economics consists of applying economic theory, the other being that the art of economics is largely non-economic given all the factors that should be taken into account when aiming to solve a particular practical problem. In the first interpretation, practical precepts are formulated solely based on economic theory. Given that solving a particular practical problem also involves many non-economic factors, this first interpretation can only deliver conditional solutions to practical problems—conditional on all relevant factors that the economic theory used omits.[2] Regarding the second interpretation, Keynes notes that objections may be raised concerning the art of economics occupying too broad a range, as a result of which there is little gain in distinguishing the art of economics from general political and social philosophy. Unfortunately, it is outside the scope of this essay to rehearse the discussion that Keynes presents throughout his second chapter, hence we should satisfy ourselves here with Keynes' conclusion that "a definitive art of political economy, which attempts to lay down absolute rules for the regulation of human conduct, will have vaguely defined limits, and be largely non-economic in character" (1891, p. 80). Hence, Keynes prefers the second interpretation of the art of economics.

[2] Keynes notes that this also brings the risk of forgetting that the formulated precepts under this interpretation are conditional, which would lead an economist to "subordinate all considerations that are not purely economics" (1891, p. 55)

An important point noted by Keynes is the relativity of the precepts generated by the art of economics. The exact practical problems, the factors causing the main problems of a given society, the factors influencing the effectiveness of various solutions, and (presumably) many other factors will differ per society, due to which the art of economics cannot simply formulate a list of precepts that work for all societies. The art of economics thus depends on the conditions prevailing in a given society. A further methodological point that Keynes advances is that abstract methods of treatment, though they work well for purely theoretical questions, cannot take us very far in applying economics to practical problems.

Skipping a bit more than a century, Colander (2001) follows Keynes in making the same tripartite distinction between positive, normative, and applied economics (i.e., economics as an art), stating that the art of economics consists of relating "the lessons learned in positive economics to the normative goals determined in normative economics" (p. 20). Policy relevance, Colander argues, should be of no concern to the economist working on positive economics; instead, positive economists should be allowed to use their imagination to construct new theories and models that, someday, may inspire policy making or solutions to other practical issues. Applied economists, on the other hand, should not be constrained by the formalistic methods that are in use in positive economics. Indeed, they cannot only make use of such formalistic methods given that any practical application of economic theories should take into account multiple non-economic and non-exact dimensions such as historical, political, and social dimensions.[3] Furthermore, Colander argues that from the fact that the exactness of an answer depends on the least exact factor determining the answer, it follows that using very exact input based on formal economic theories is useless if other dimensions are much less exact. Hence, the art of economics does not need to be formal or very exact; instead it should be more sensitive to various dimensions that are important in the real world.

Given this, we can conclude that the *purpose* of the art of economics is solving real-world problems, for which it uses a *methodology* that is (usually) not formal, not very exact, and largely non-economic given the various dimensions that need to be taken into account. Though it may be inspired by formal positive economics, it is not limited to this: insights from other disciplines (such as sociology or politics), practical reasoning, and educated common sense can and do play an equally important role.[4]

1.3 Historical Perspectives

The discussion with which we started this chapter already identified policy making as having been an important element throughout the history of economics. Backhouse (2002) notes that, especially in the earlier phases of economic thinking,[5] many economists usually did not hold or only partially held academic positions. Ricardo, for instance, was a stock broker; von Thünen was a farmer; Cournot was mostly a university administrator; and Minard was an engineer. Those economists were usually not so much driven by pure intellectual curiosity

[3] Of course, one could even wonder how exact positive economics can possibly be.

[4] Note that the art of economics is not necessarily the same as the art of public policy. The fourth chapter will spend some more words on the distinction between them.

[5] Where with 'earlier phases' I mean to refer to the period until, say, halfway the 19th century.

about the workings of the economy, but by practical (policy) problems. Inter alia as a result of this, most economists did not engage much in formal abstract theorizing but instead relied on a combination of economic, political, social, and practical arguments and insights to argue in favor or against certain policies. For instance, Adam Smith combined moral philosophy (in his *The Theory of Moral Sentiments*, 1759) with economic and practical insights (in his *The Wealth of Nations*, 1776) in his economic thinking. At the same time, there were a number of economists, in particular David Ricardo, who argued in favor of more abstract reasoning. Against this, the historical school argued that economists should take historical contingencies into account and that hence the focus should not be on abstract theorizing (which was accused of having limited relevance) but on an inductive, historical approach (Backhouse, 2002). It should be noted, though, that it does not follow that the historical school recognized the distinction between positive economics and economics as an art; rather, they can be seen as blending the art of economics with positive economics, thereby focusing (more) on the economics-as-an-art element.

At some point, economics institutionalized as an academic discipline. When exactly this happened depends on which country one looks at: for the United States and Great Britain, this institutionalization happened during the last decades of the nineteenth century, whereas for Germany and France this change had already happened some decades earlier. As a result, in contrast to the classical period, most economists were full-time academics. Furthermore, economics seemed to move away from their roots in political philosophy and become more of an autonomous science.

At first, this move did not change much with respect to how economists generally perceived economics and public policy. For instance, the full-time academic economist Alfred Marshall did not see much use for abstract mathematical economic theories when making policy (or when doing economics more generally)—though it must be noted that Marshall at first argued against separating the art of economics and the positive science of economics, a view that he—arguably under the influence of Keynes—changed later in life (Colander, 2001). However, during the 1930s the economics profession changed (Colander and Kupers, 2014). In particular, the profession became much more focused on pure (and mathematical) theory, and "instead of seeing theory as something to keep in the back of their mind when dealing with real-world problems, economists began to see economic theory as a central tool to be used by policy makers" (Colander and Kupers, 2014, p. 79)—thus forgetting about Keynes' tripartite division of the field of economics. As Backhouse (2002) puts it, economics had "come to be structured not around a set of real-world problems, but around a set of techniques" (p. 238), This approach was pioneered by the nineteenth-century economist Léon Walras and continued by many economists after him (Colander and Kupers, 2014). For example, one economist that quite radically followed Walras was Abba Lerner, who developed exact formal models of the economy and saw their conclusions as directly applicable to government policy—thus forgetting about Keynes' warning for mischievous errors.

This brings us to Milton Friedman, whose essay on the methodology of positive economics (1953) had a great influence on the field of economics. At the very beginning of his 1953 essay, Friedman cites Keynes' (1981) tripartite division of economics—only to mostly ignore it in the rest of his essay. In particular, the art of economics is mostly ignored or seemingly lumped together or equated with normative economics (though the way Friedman discusses positive economics strongly suggests that he in fact sees positive economics and applied economics as the same domain). For instance, Friedman argues that policy conclusions must necessarily be based on positive economics given that choice of policy should be based on predictions regarding the consequences of that policy (implying that positive economics can make accurate real-world predictions). Nevertheless, he also argues that there is no one-to-one relationship between the conclusions of positive science and policy conclusions because different individuals may find different consequences desirable. Hence, a discrepancy between positive economics and policy conclusions can exist, be it as a result of normative considerations, not as a result of practical considerations.

Interestingly, Colander (2001) argues that Friedman's actual work belongs in fact to applied economics—i.e., the art of economics—, not to positive economics. Friedman focused on solving concrete problems, he was not looking for principled answers. Had he been given the choice between doing applied policy analysis or positive economic analysis, Colander argues that "he would have unequivocally decided on applied policy economics, arguing that such applied work should be the primary concern of economists" (2001, p. 31), and notes that Friedman's instrumentalism fits well with doing economics as an art.

Regardless of this, the economics profession has only internalized the distinction between positive and normative economics. Moreover, the mischievous errors that Keynes warned for only became more severe due to the economics profession becoming more Walrasian—in contrast to Friedman, who considered himself a Marshallian (Colander, 2001). In other words, the economics profession focused much more than Friedman on constructing (and applying) abstract mathematical theories then on solving real-world problems. As a result of this, economists fell in the trap Keynes (1891) warned against: to ignore the relativity of applied economics, i.e. to ignore the different conditions prevailing in different societies that therefore require different policies, leads to mistakenly thinking that positive economic theory can be applied universally. The ineffectiveness of doing so would then lead people to over-state the relativity of positive economic theory. Much of today's criticism on the economics profession may in fact be this phenomenon, given the quite common focus of this criticism on unrealistic assumptions and failures to resolve real-world problems. Recognizing a separate art of economics is likely to make the profession much more well-equipped to take on real-world problems and may help resolve or at least clarify the debate on unrealistic assumptions as well.

1.4 The Relevance of (the Art of) Public Policy

The general relevance of public policy is quite straightforward. This relevance consists of, inter alia, public goods provision, implementing laws, maintaining law and (some) order, regulating economic activity (e.g. in financial markets or against monopolistic tendencies), and trying to achieve some collective societal goals (e.g. reducing pollution or fighting poverty). In other words, public policy addresses collective or societal problems, ranging from coordination problems to free-riding problems and problems pertaining to asymmetric information.

Given this general relevance of public policy, what in particular is the relevance of viewing public policy as an art? A historical example illustrating this relevance may be the potato famine that took place between 1845 and 1849 in Ireland, which unleashed a discussion between those economists inclined to adapt a universal *laissez-faire* perspective and economists of the historical school such as Cliffe Leslie (Hodgson, 2001). The general position of the historical school regarding the way economics should be done can arguably be seen as being much closer to the notion of economics as an art compared to the more universal-principles-inclined economists on the other side of the debate. The reason for this is that the historical school emphasized differences between societies, based on which they argued that economic theories should take into account the characteristics of particular societies instead of pretending to be universally valid theories that apply to all societies (although, as noted before, they did not distinguish between positive economics and the art of economics). Returning to the Irish potato famine, historicist economists argued that while the *laissez-faire* approach that was implemented in Ireland may be suitable for developed market economies such as England, it was not suitable for societies such as Ireland. Public policy approached as an art would arguably have come to a similar conclusion, given that it is not focused on applying abstract (and universal) theories but on solving practical problems—of which the Irish potato famine certainly is one. Assuming for the sake of the argument that the historical economists were correct, if public policy would have been perceived as an art the effects of the Irish potato famine would likely have been much less severe.

In a more contemporary context, Colander (2001) argues in a chapter co-authored with former Federal Reserve Governor J. Dewey Daane that academic economists working on monetary policy often engage too much in pure abstract theorizing without institutional foundations. The work of those economists, they argue, would be much more useful if they focused more on the actual practice of monetary policy than on 'high theory'. A contemporary example in the context of regulating the financial sector is the criticism that Taleb (2012) raises, which boils down to regulators (and academic economists advising them) having been too focused on idealized economic theory, thereby forgetting about issues that are important in the real world. Again, recognizing the art of economics besides positive and normative economics would likely have avoided those valid criticisms.

One of the main reasons why it is important to view public policy as an art resides in the complexity of socioeconomic phenomena (Colander and Kupers, 2014). Any model is a simplification, as it should be, and given the complexity of socioeconomic phenomena it follows that models of such phenomena will necessarily abstract from many messy details. Even complexity science "can create a model only for the simplest social systems; so any model will be only a rough guide, and not provide any definitive rule about policy" (Colander and Kupers, 2014, p. 274). Hence, while abstraction is necessary, the result is that conclusions based on abstractions cannot simply be applied to practical issues.

What makes socioeconomic phenomena complex is the interdependencies between different individuals and between the different expectations of those individuals (or more generally the interdependencies between the various elements in a socioeconomic system). Now Keynes (1891) already noted that as civilization advances, economic life becomes more complex as individuals become increasingly dependent on each other, a phenomenon that Keynes seems to attribute to increases in the division of labor. This is supported by both perspectives discussed in this thesis: Colander and Kupers (2014) argue that societal problems in our contemporary world are increasingly complex due to increased interconnectedness between various aspects of society, and Taleb (2010, 2012) argues that the world is becoming increasingly complex due to (inter alia) processes of globalization and (resulting) specialization, which ultimately increase the degree of interdependencies and hence the complexity of our world.

If, then, the need for viewing public policy as an art is for a large part based on the complexity of socioeconomic life, and if the complexity of socioeconomic life is increasing, it follows that viewing public policy as an art will only increase in importance.

Chapter 2

Perspectives from Complexity Theory

Govern a great nation as you would cook a small fish. Do not overdo it.
—Lao Tzu

2.1 Introduction

In their 2014 book titled *Complexity and the Art of Public Policy: Solving Society's Problems from the Bottom Up*, David Colander and Roland Kupers propose a new frame for public policy discussions. Instead of the current standard frame that includes a rather fundamental dichotomy between pro-market and pro-government stances, they propose to look at public policy from a complexity frame. The core of their proposed complexity frame consists of seeing society as a complex evolving system that is more like a living organism than a mechanistic clockwork, that can be influenced but not controlled, and in which both market and government are endogenously evolved elements. As a result, they argue, we should focus on different kinds of policy goals and policy issues than we do now; no attempts to control the system, our power is limited to attempts at influencing the evolution of the system in a positive way.

Though the project of complexity science already has some decades of history, the work of Colander and Kupers is one of the first that explores implications for public policy. There are some other recent publications such as Room (2011), Morçöl (2013), and Geyer & Cairney (2015); however, Colander and Kupers are the first in outlining a complexity *frame* for public policy. It is important to note here that Colander and Kupers do not intend to provide a blueprint for public policy telling policy makers what policies to pursue or not to pursue. Instead, Colander and Kupers aim to provide a frame for public policy, a way of thinking about public policy based on viewing society and the economy as complex evolving systems.

This chapter presents the complexity frame proposed by Colander and Kupers (2014). It will do so by first discussing characteristics of complex evolving systems (section 2.2), after which it outlines the complexity frame for public policy proposed by Colander and Kupers (section 2.3). Section 2.4 succinctly discusses Kirman's (2016) position on the matter, which will be used in the critical discussion in chapter 5. The last section concludes.

2.2 Characteristics of complex evolving systems

This section first presents the general core characteristics of complex systems based on a somewhat broader literature than only Colander and Kupers (2014). Subsequently, it discusses features of complex systems that Colander and Kupers highlight.

2.2.1 General core characteristics of complex systems

What is a complex evolving system? There are a number of definitions, or more accurately, characterizations of complex evolving systems in the literature that are usually based on certain characteristics that complex systems exhibit. A single comprehensive definition of a complex evolving system cannot be given, for any definition of complexity depends on the perspective one takes (Manson, 2001; Rosser, 1999). Also, different complex systems may exhibit different characteristics, and different characteristics may be of interest to a researcher dependent on the system or problem at hand. According to Manson (2001), there is however one common element in all complexity research, being that it is "concerned with how the nature of a system may be characterized with reference to its constituent parts in a non-reductionist manner" (p. 406).

A core element that pertains to all complex systems is the *interconnectedness* between its individual elements (Cairnes, 2012; Taleb, 2009a). This interconnectedness, in the sense of (nonlinear) interactions between and interdependence of (the behavior of) individual agents in the system, is what makes complex systems difficult or impossible to model by using simplified linear models. In fact, "The more interconnected parts to a system, the more likely it is that the system is best analyzed as a complex system" (Colander and Kupers, 2014, p. 46). Absence of a large degree of interdependencies allows for describing a system adequately based on linear models.

This high degree of interconnectedness in complex systems gives rise to two other core elements of complex systems, namely *feedback loops* and *nonlinear dynamics* (Cairnes, 2012; Taleb, 2009a; Arthur, 2013). Feedback loops are self-reinforcing (in the case of positive feedback loops) or self-correcting (in the case of negative feedback loops) mechanisms; self-reinforcing mechanisms make a system prone to explosive propagations of changes, whereas self-correcting mechanisms 'keep the system in check' (Arthur, 2013). A complex system has a mix of positive and negative feedback loops, due to which they exhibit some stability or order. In contrast, chaotic systems only have positive feedback loops, due to which the system does not correct itself. The result is chaotic behavior. Linear systems only have negative feedback loops, which makes the system static. Colander and Kupers illustrate the relevance of feedback loops using a study of the dynamics of the distribution of wealth by Axtell and Epstein (1996). The study suggests that feedback loops between the wealth and income of an agent may by themselves cause a highly skewed income distribution, independent of differential abilities on behalf of the agents.

The existence of nonlinear dynamics means that, unlike in linear systems, causes and their effects are not (necessarily) proportional to each other. An example that Colander and Kupers discuss is Schelling's model of segregation, where slight racial prejudices over time resulted in complete segregation (Schelling, 1971). More generally, without nonlinear dynamics many of the features that characterize complex systems would not arise. Nonlinear dynamics are thus an essential feature of complex systems.

2.2.2 Features of complex systems relevant to the complexity frame

Colander and Kupers do not give an explicit definition but discuss a number of characteristics of complex systems that are relevant for their proposed complexity frame (Colander and Kupers, 2014, in particular chapter 7, 4, and 1). One important characteristic that they note is that complex systems have a *fractal* nature. This means that the system exhibits self-similarity at multiple scales. A common illustration of fractals is provided by a tree: stems split into large branches, which in turn split in smaller branches, which in turn split in twigs. This splitting up in smaller elements can be seen at multiple scales (e.g. when zooming out at the scale of a stem splitting into branches, or when zooming in at the scale of twigs splitting into smaller twigs). The fractal nature of a tree is thus caused by the rather simple rule of a branch splitting every so often. The rules that are responsible for the fractal nature of a system are called *replicator dynamics*. The possibility of identifying those replicator dynamics is important for complexity science, as it allows for a better understanding of the workings of the system and the modelling of such fractal systems.[6] A feature of fractal systems that is important for policy is that small changes in the replicator dynamics of a system—the rules governing the evolution of that system—can have large effects on the resulting structure or behavior of the system.

Another characteristic discussed by Colander and Kupers is *emergence*, meaning that out of the interactions between individual elements in the system new patterns emerge. Complex evolving systems often display a certain emergent order. An example is the formations in which birds fly, which are based on simple interaction rules between any two individual birds. Self-organization of complex systems is another example of emergence. The most obvious example in economics is the emergence of prices in (free) markets. Another example is investor herd behavior (Manson, 2001).

A further characteristic of complex systems is the existence of *basins of attraction*. Whereas non-complex systems often have a unique equilibrium, complex systems often display multiple equilibria, or multiple basins of attraction. A basin of attraction is characterized as "a pattern or an outcome toward which the system evolves" (Colander and Kupers, 2014, p. 53). A complex system does not tend to one unique equilibrium but can move from one basin of attraction to another. Which basin of attraction a system moves towards may be influenced by only minor changes in the system or rules underlying the system. A major aspect of Colander and Kupers' complexity frame is the idea that policy should try to nudge the social and economic system towards more desirable basins of attraction (which will be discussed in more detail in section 2.3).

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[6] Note the difference between how complexity science aims to deal with interconnectedness in systems compared to how non-complexity science deals with this: whereas non-complexity science tends to abstract from this interconnectedness, complexity science focusses on the interconnectedness inter alia by focusing on the underlying rules of this interconnectedness. An important tool for complexity science in this respect is agent-based modelling.

Complex systems exhibit *path dependence*. In the words of Prigogine and Stengers (1984), "complex systems carry their history on their back" (quoted in Colander and Kupers (2014) p. 119). This means that the evolution of the system depends on its past trajectory. Path dependence can for instance be used for analyzing the phenomenon that similar shops often are located in close proximity to each other: once some concentration of similar shops is established, it is attractive for new shops to settle there in order to profit from the bigger flow of customers attracted to the concentration of shops.[7] Path dependence can lead to so-called *lock-ins*, situations that persist even though they may not be desirable. A famous example is the QWERTY keyboard, which had been designed with the purpose of preventing typists from typing too fast due to concerns about jamming of the letter hammers in type-writers that were used back when the QWERTY keyboard was introduced. Better keyboard designs have been introduced since, but due to lock-in effects the QWERTY keyboard is still in place.

Another characteristic of complex systems is that its dynamics can change almost instantly. This happens when there is a *phase transition* or when the system reaches a *tipping point*. A policy that Colander and Kupers use to illustrate this phenomenon is one introduced in Ireland in 2008, where a small tax on plastic bags was introduced. As a result, in a few months the use of plastic bags decreased dramatically in a matter of months: the plastic bag tax 'tipped' the system over to different patterns of behavior. One could argue, however, that this example does not show that phase transitions are features of complex systems, for it can be analyzed using non-complex models (e.g. by arguing that the tax resulted in the marginal costs of plastic bags being higher than the marginal benefits for most consumers). An example that may illustrate phase transitions in complex systems better than this example by Colander and Kupers is the start of the First World War: the assassination of Archduke Franz Ferdinand of Austria nearly instantly resulted in very different geopolitical dynamics, namely the dynamics of World War I. Other examples include bank runs and, perhaps, the onset of the 2008 financial crisis.

The role of *diversity*, or variation, is important in stabilizing (the behavior of) complex systems. This may sound counterintuitive, but it can be illustrated clearly in the context of our food system. In the late 1990s, swine fever hit the Netherlands, which necessitated killing a total of eleven million pigs to prevent the disease from spreading. If there would have been more diversity in the kinds of pigs, with not all kinds vulnerable to this swine fever variant, killing a much lesser number of pigs would have been sufficient.

Often, complex systems can be modelled as networks, with network theory being a subfield of applied mathematics studying them. Questions studied include those pertaining to the resilience of a network and questions about contagion (i.e. the spread of information, norms, and the like throughout a network). A potentially fruitful application of network theory could be in the financial sector, where it may help assess systemic risk based on contagion of bankruptcies in the banking network.

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[7] Notice the close relation with feedback loops: the initial concentration of similar shops increases attractiveness for settling there, which in turn increases the concentration of similar shops in that location (arguably up to a point).

2.3 Colander and Kupers' complexity frame

This section first discusses why Colander and Kupers deem the standard frame for public policy insufficient. Though the way in which Colander and Kupers portray the standard frame may be a bit too simplified, given that their purposes are contrasting the complexity frame with the standard frame and arguing for *adding* the complexity frame to the set of available frames (not *replacing* the standard frame with the complexity frame), the expedience of and clarity resulting from this simplification outweighs the resulting loss in accuracy of representation. The section then continues by presenting Colander and Kupers' complexity frame (section 2.3.2).

2.3.1 Why the standard policy frame does not suffice

Colander and Kupers (2014) portray the standard policy frame as a discussion between two polar opposites—the laissez-faire approach versus government activism.[8] Both positions, they argue, leave out the fact that in complex systems, policy choices will influence the dynamics of the system itself as well as the preferences of the individuals in the system. In other words, those positions ignore the interconnectedness and hence complexity of society. Although Colander and Kupers acknowledge that more sophisticated defenders of government or the market—those who understand that society is a complex evolving system—exist, they argue that policy discussions are often placed in the standard policy frame that does not allow for much sophistication or nuance regarding the complexity and interconnectedness of the system.

To illustrate the difference between the standard policy frame and the complexity frame, Colander and Kupers use the story of a major intersection in a Dutch town called Drachten. This intersection does not have traffic lights, traffic signs, or any other form of top-down rules that control behavior. Nevertheless, it is not a big mess. In fact, traffic flows—on average—a bit faster, and there are fewer accidents. The lesson to be learned from this story is not that we should get rid of the government and install anarchy; instead, the lesson involves the contrast between top-down and bottom-up solutions in relation to the standard- and the complexity frame. In particular, Colander and Kupers argue that the bottom-up approach that forms the basis of this intersection is intelligible only in the complexity frame. The standard frame can only make sense of intersections with top-down controls; local interactions between users of the intersection based on relevant norms and resulting emerging patterns only makes sense from a complexity perspective. Still, the government has played an important role in the story of Drachten's intersection, for without the existence of driver's licenses, car safety standards, and criminal law, amongst others, the bottom-up approach to this intersection would likely not have worked, or not have worked as efficiently as it does now. Hence, there is a role for government, but it is more of a facilitating role than a steering role. In this sense, the complexity frame sees market and government as complementary: the government should facilitate bottom-up approaches such as the market, for instance by establishing and enforcing property rights.

[8] This does not mean that Colander and Kupers see economic science as involving two diametrically opposed positions; their work discusses frames for policy debates, not frames for economic science.

In the standard frame, the government often acts as a controller. However, in a complex system there is no such thing as top-down control; at most, the dynamics or the evolution of the system can be influenced. The idea that the government can control (certain elements in) society or the economy is one reason why the standard frame with respect to the role of government does not suffice. Related to this, Colander and Kupers detect a tendency in the standard frame to think of the government as somehow outside the (economic) system. A complexity perspective recognizes that this is not the case. Instead, it sees the government as an entity that has endogenously evolved within the system and is continuously evolving—just like the market or the judicial system. Another reason for the insufficiency of the standard frame is that there is not much discussion about so-called *metapolicy*. In contrast, metapolicy is a central element in the complexity frame. It refers to establishing, maintaining, and further developing a certain ecostructure in society through which bottom-up approaches can be encouraged (or discouraged)—more on which in section 2.3.2.

So far, Colander and Kupers argue, proponents of market fundamentalism would mostly happily agree with the story, given the focus on the impossibility of the government controlling or steering the system. However, even though the complexity frame is closer to free market proponents than proponents of strong government interventionism, it has a markedly different view on the role of government. Whereas laissez-faire approaches often view the government as a hindrance or obstacle, the complexity frame recognizes that governments have an important role to play—be it a different, more facilitating type of role than the role envisaged by proponents of government steering and control.

2.3.2 The complexity frame proposed by Colander and Kupers

We have already touched upon some elements of the complexity frame through which, according to Colander and Kupers, public policy should be seen. This section outlines their proposed frame more precisely and comprehensively.[9] First, though, it should be emphasized again that Colander and Kupers do not provide a blueprint for policy making, nor do they argue for any particular policies. Instead, their frame is a certain perspective on public policy based on recognizing the complex nature of society and the economy. The issue is thus "one of framing, not of knowledge" (2014, p. 10). The main effect of adopting a complexity frame instead of the standard frame is twofold, namely seeing the *aim* or *role* of public policy differently and, as a result, focus on different *kinds of* policies and public policy issues.

Preliminaries. Before looking into the role of and kinds of public policy in the complexity frame in more detail, it is important to note that the complexity frame does not and cannot give definitive and precise answers to questions about which policy out of a set of alternative policies is preferable—also not 'merely' theoretical answers. The reason Colander and Kupers give for this is, quite simply, the inherent uncertainty in complex systems. As a result, making

[9] The project of Colander and Kupers is mainly intended to familiarize people with and convince them of the relevance of the complexity frame. It is not a thorough philosophical treatise. The representation of the proposed complexity frame in this section is more (explicitly) structured than in Colander and Kupers' book, simply for the sake of clarity of exposition. In doing so, I have attempted to represent their position most charitably and plausibly while trying to remain close to their original exposition in so far fruitfully possible.

(sufficiently) accurate predictions in complex evolving systems is a very difficult, if not impossible task, and predicting what the effects of a specific policy will be is close to impossible.[10] Therefore, instead of providing precise policy recommendations, the complexity frame provides a way of thinking about policy. As Colander and Kupers put it, "In the complexity frame, scientific models provide a vision for policy, not an answer for policy" (2014, p. 16). How does this work? By trying to understand what Colander and Kupers call the topography of the system. This understanding in turn helps to guide policy making. No definition of the 'topography of the system' is offered in their book, but a plausible interpretation is one in terms of natural features and structural relationships that obtain in a system.[11] Having a general idea about the features and relations obtaining in a system enables one to think about possible policies and possible effects of policies, even without having detailed knowledge about all mechanisms and factors that play a role in the policy area under consideration. Colander and Kupers claim that this is much in line with how John Stuart Mill approached policy: whereas he based his analyses on formal economic models, his policy approach was much more intuitive. Scientific models can only provide 'half-truths' for policy making, or so Mill (1848) argued.

One may object here that this means that there will be policy failures in the complexity frame. While this is true, it is not a valid objection. Policy failures will always be part and parcel of policy making, also in the standard frame. What is important, Colander and Kupers note, is that policy makers should learn from those failures, as they provide information on what (types of) policies do or do not work. "[T]rue failure is not trying at all" (Colander and Kupers, 2014, p. 208). Furthermore, in the complexity frame the science of complexity is not the only source of information for policy makers, for intuition, common sense, and practical knowledge can inform policy makers as well. The ultimate compass for policy making in the complexity frame, Colander and Kupers claim, is simply highly educated common sense.

Aims and Role of Public Policy. Having noted this, we can turn to the question of the aims and role of public policy in Colander and Kupers' complexity frame. While Colander and Kupers do not explicitly define an overarching goal for public policy in their complexity frame, a twofold definition they would arguably agree with is that public policy should (1) ensure the survival of and (2) have a positive influence on the evolution of (institutions in) the complex system that forms society.[12] In the standard frame, Colander and Kupers claim, the survival of the system is an issue that is left unaddressed. In the complexity frame, in contrast, it makes a lot of sense to think about the resilience of the system, i.e. "the capacity of a system to absorb and adjust to change by learning from it" (Colander and Kupers, 2014, p. 200). The reason for aiming to ensure the survival of the system is simply that if the system does not survive, other goals that society may have cannot be achieved. Hence, survival of the system

[10] This difficulty of prediction in complex evolving systems is recognized by many authors working on ideas linked to complexity (see e.g. Arthur, 2013; Cairnes, 2012; Orrell and McSharry, 2009).

[11] One definition of topography found in the Merriam-Webster dictionary states that a topography is "*the physical or natural features of an object or entity and their structural relationships*" (https://www.merriam-webster.com/dictionary/topography)

[12] See e.g. Colander and Kupers (2014) p. 8, p. 53, p. 182, p. 199-200, and p. 274. This two-fold definition is due to the present author, all substance discussed under this two-fold definition is due to Colander and Kupers (2014).

is one important focus of complexity policy. The role of policy in trying to positively influence the evolution of the system is understood by Colander and Kupers as nudging the system from undesirable basins of attraction towards more desirable basins of attraction. This is done using an approach to policy that they call *laissez-faire activism*:

> "[Laissez-faire activism] is an approach that encourages activist policies designed to create an ecostructure within which laissez-faire policy can flourish. It is a policy designed to create a viable social ecostructure in which individuals, or collections of individuals, solve problems from the bottom up, without the use of a central coordinator. Activist laissez-faire policy is a bottom-up policy within which people help solve problems as efficiently as possible through voluntary, collective, and cooperative self-imposed modification of their selfish impulses" (Colander and Kupers, 2014, p. 61)

The major difference between this approach and the standard frame is that the role of public policy in the standard frame predominantly seems to be solving given problems instead of, as in the activist laissez-faire approach, enabling people to solve problems via bottom-up processes.

Survival of the System. Given this role for public policy, what kinds of policies should we adopt, and what kind of policy issues arise? Colander and Kupers identify two public policy issues that affect the resilience, and hence the survival, of the system.[13] The first issue concerns the role of diversity. In the previous section discussing characteristics of complex systems, we noted that diversity is important in stabilizing (the behavior of) complex systems. This was illustrated by an example concerning a swine flu outbreak, which due to the lack of diversity in different kinds of pigs necessitated killing a great number of pigs to prevent the flu from spreading further. Furthermore, Colander and Kupers refer to Scott Page (2007), who has demonstrated that diversity in complex systems makes such systems function better and more smoothly. Colander and Kupers claim that Silicon Valley is an example of successful innovation hubs in which diversity plays a central role. This, however, is not to say that diversity is always beneficial, in every form or measure; one needs the right kind and the right amount of diversity for the system under consideration.

Furthermore, Colander and Kupers argue that diversity may come at the cost of efficiency. Hence, there is a trade-off to be made between efficiency and resilience, often in particular between *local* efficiency and *global*, or systemwide, resilience. This trade-off is the second public policy issue concerning resilience that Colander and Kupers identify and discuss. A clear example is the highly efficient just-in-time-delivery supply chain that was in place in the automotive sector in Japan in 2011, which was disrupted due to the tidal waves hitting Japan in March that year. This just-in-time supply chain maximizes efficiency by delivering the right products at the right time, hence minimizing the need for storage- and related costs. The disruption due to the tidal waves that hit was massive: returning to full production cost many months. Note that Colander and Kupers do not argue that resilience always comes before efficiency; it is a trade-off, whether efficiency considerations are more important or valuable

[13] Given that Colander and Kupers repeatedly note that they do not want to argue for particular policies but for a certain policy frame, any lists of (kinds of) policies that they provide should not be interpreted as (necessarily) being an exhaustive list.

than resilience considerations depends on the context, and perhaps on the interests of the stakeholders involved. For instance, it may or may not have been the case that the highly efficient just-in-time supply chain system in Japan's automotive sector produced so many efficiency gains that the costs due to the long disruption of the system were outweighed by them. A second example provided by Colander and Kupers of this trade-off concerns the road to the financial crisis of 2008, where improvements in local efficiency through financial innovation came at the cost of global resilience for the banking sector, which in turn allowed the crisis to happen (or at least intensified the crisis considerably).

Positively Influence the Evolution of the System. Turning to the second goal of policy in the complexity frame, one may wonder what it means for Colander and Kupers to positively influence the evolution of the complex system of society. The answer is to guide evolutionary pressures to desirable ends, or, more precisely, "moving the economy from an undesirable basis [*sic*] of attraction to a more desirable one" (Colander and Kupers, 2014, p. 53). This results from the recognition that there is no unique or optimal equilibrium that the economy automatically moves towards and that there may be undesirable lock-in effects that need to be overcome by collective action (thus moving the economy towards a more desirable basin of attraction). Colander and Kupers identify two overall kinds of policies or policy issues that are relevant in this respect, namely *ecostructure* policy, or metapolicy, and *norms* policy. Ecostructure policy is defined as influencing "the very rules that determine the emergent dynamics of the whole system" (Colander and Kupers, 2014, p. 24). Norms policy, on the other hand, is a kind of policy that aims to enable the expression of collective choices about desirable norms and tastes by developing relevant institutions.

Ecostructure policy is rather broad. Examples include supporting a well-functioning market by establishing and enforcing property rights, protecting individual freedoms via the checks and balances provided by the U.S. Constitution, and the regulations that aim to determine the behavior and dynamics of the financial sector. Indeed, government itself operates within a certain ecostructure, it for instance functions within a certain institutional set-up.

An example of an ecostructure policy that is discussed elaborately by Colander and Kupers concerns encouraging the development of so-called for-benefit institutions (also known as social entrepreneurship). Those are institutions that aim to achieve some socially desirable goal, which may include goals that are currently delegated to direct government policy. The relevant ecostructure would roughly consist of creating a legal and institutional structure that enables the creation of such for-benefit enterprises. This example clearly illustrates the cooperation between government action and bottom-up approaches that is desirable in the proposed complexity frame: "It is a bottom-up ecostructure policy meant to turn the power of the market toward social problems" (Colander and Kupers, 2014, p. 219). One existing for-benefit institution is a cooperation between the multinational Danone Yogurt and the micro-finance pioneer Grameen, who together created a business that has fighting undernourishment in rural Bangladesh as its primary goal. Another example is Grayston Bakery, which aims to train hard-to-employ workers in order to improve their job prospects. Those two examples not only show that undesirable (local) situations can be addressed by efforts coordinated in a (local) market economy—which is nothing new—, they also strongly suggest that for-benefit institutions are viable organizational structures that are capable of addressing (local) societal problems and that, in greater numbers, may affect the (evolution of) the whole system. This policy of enabling (and encouraging) for-benefit institutions is one way of achieving the more general goal of ecostructure policy of encouraging or catalyzing creative bottom-up approaches that aim to achieve social goals or solve collective-choice problems.

It is important to note that ecostructure policy does not involve grand projects. Instead, Colander and Kupers claim that “a small change in the ecostructure especially when applied at the formative embryonic stage of emerging institutions can fundamentally change society from the bottom up, without massive state intervention” (Colander and Kupers, 2014, p. 216). This idea of small changes aiming for larger effects is related to the replicator dynamics discussed in section 2.2, where the idea is to tweak those replicator dynamics in order to alter the evolution of the system as a whole.

In more general terms, ecostructure policy is about positively influencing the evolution of institutions (e.g. supporting the development of for-benefit institutions) and adequately coordinating individual actions without the need for a central controller (e.g. the Drachten junction example). One may wonder how the government can decide what is a ‘positive’ influence on the evolution of certain institutions. The answer, according to Colander and Kupers, lies in viewing government as an institution through which individuals can decide on collective issues, amongst which the goals of society. The goals of policy should reflect those goals of society, which means that ‘positive’ influences are those influences that help society to achieve certain goals or nudge the system to some basin of attraction collectively deemed desirable. This is a different view of government than in the standard frame (at least as portrayed by Colander and Kupers, see section 2.3.1), where the government is often seen as a controller that is exogenous to the system.

Lastly, Colander and Kupers note that the ecostructure of a complex system also evolves over time, along with the evolution of that complex system itself. For instance, interpretations of U.S. constitutional law (a form of ecostructure policy) by the Supreme Court often results in new laws. Ensuring that changes or developments in ecostructure policy is focused on the long-run benefit of society instead of interests of certain groups or stakeholders is not easy, for bottom-up approaches usually take more time, will not be perfect, and may result in harm for certain groups in the short-run. Trying to prevent such problems from affecting which policies are enacted brings us to the ecostructure of government itself, though it is useful to first discuss norms policy—the second main kind of policies or policy issues in the complexity frame—in more detail.

Norms Policy. The complexity frame explicitly recognizes that norms are not fixed. Combining this with viewing the government as an institution via which people can make collective choices about societal goals and with recognizing the important role that norms play in a complex social system, Colander and Kupers argue, opens up the possibility for a debate about norms policy. Having a norms policy does not mean that the government is trying to impose its will on individuals, for Colander and Kupers view government as a collective-choice institution. Therefore, in that sense, norms policy can be seen as a form of internal paternalism, that is, individuals exercising (collective) self-control.[14] Colander and Kupers argue that

[14] This fits well with the more general view of government in the complexity frame as an endogenously evolved control mechanism.

society, like individuals, can be seen as having multiple 'selves' with different preferences. Norms policy can then be seen as society's 'reasoned' preferences trying to influence society's 'impulsive' preferences.[15] The ultimate goal that Colander and Kupers have in mind is "creating a civil society within which individuals can prosper on their own terms" (2014, p. 9) by developing institutions that "better allow people to express their collective choice about what norms and tastes should be encouraged and discouraged by society" (2014, p. 183). In line with the overall complexity frame, the development of such institutions and the encouragement or discouragement of certain norms is supposed to happen via bottom-up processes. One advantage that Colander and Kupers claim for this approach towards norms policy is that, if successful, the internalization of certain social norms by individuals diminishes or even eliminates the need for (certain) government interventions. For instance, if for-benefit institutions become the norm this may well result in the government not having to intervene to achieve a number of social goals because they are already being dealt with by such for-benefit institutions. Colander and Kupers also refer to another clear example of norms diminishing the need for government intervention or control due to the work of Elinor Ostrom, who has shown that successful management of shared resources has evolved bottom-up in many societies. This usually involves individuals internalizing certain norms that are responsible for the success of the evolved approach,[16] which in turn eliminates the need for any centralized form of control of those shared resources. An example given by Colander and Kupers that shows how government may encourage the development of pro-social norms without exercising control concerns the municipality of Bogota, Columbia, which around the turn of the century started building sidewalks in crime-ridden neighborhoods. The idea behind this policy was to enable people to meet on the streets and hence strengthen social cohesion and social norms that come with that. The policy turned out to be highly successful, for crime rates decreased considerably in the relevant neighborhoods.

Ecostructure of Government. Turning to the ecostructure of government, we have seen that in Colander and Kupers' complexity frame the institution of government functions as a collective-choice institution that helps in establishing and achieving social goals. Given that bottom-up processes take more time than top-down initiatives in achieving set goals, Colander and Kupers identify a considerable risk that various groups of individuals will try to influence governmental policies in such a way that benefits their group in the short-run—with the possible or even likely side effect of damaging the ecostructure conducive to achieving long-term societal goals bottom-up. The strength of the government *not to abuse its strength* in this way is called the *moral strength* of government. Hence, an important goal of the ecostructure of government is to shield policy makers from temptations to abuse their power. One aspect of this is to 'protect' civil servants from (too much) political pressure, specifically in areas such as education and health care. Whereas societal goals should clearly emerge as a result of political discussions, achieving those goals should according to Colander and Kupers be done by institutions that "must be seen as providers of a service, not political entities" (2014, p. 246). This brings us to another aspect of government ecostructure, namely the delegation of tasks and power. Colander and Kupers view government as a set of (overlapping)

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[15] Colander and Kupers base this on the idea of multiple selves prevalent in behavioral economics

[16] Note that the internalizing of such norms is a long-term evolutionary process, not a decision made by an individual at some point in time.

collective-choice institutions, not a single one. This set is evolving with the system; new (kinds of) collective-choice institutions may emerge, outmoded ones may disappear. The government not being one centralized institution helps to avoid abuses of power as well, given that powers are distributed over multiple institutions.

Colander and Kupers also advocate a hardening of budget constraints, with which they mean that some governmental institution or agency should receive a certain amount of money determined in advance, with which they should reach the goals set for that agency to the greatest extent possible. Failing to reach something sufficiently satisfactory may result in a bankruptcy of sorts, leading to a replacement of (the leaders of) the agency. Those policies are meant to minimize cost overruns, both by fixing the available budget and by enforcing skin in the game on behalf of the employees (or leaders) of a government agency.

The funding of general government (distinct from the budget considerations discussed above) is another key issue where the complexity frame differs from the standard frame. We have noted that Colander and Kupers view (some) governmental institutions as providers of a service. Given this view, they argue that it would be more than reasonable if the government would charge some kind of fee for those services.[17] For instance, the government could charge fees for patents based on the value of those patents (a payment for the service of establishing and enforcing those patents), charging institutions that required a governmental bail-out, or charging fees for using the results from fundamental research and development research performed by governmental institutions.

A last aspect of policy making in the complexity frame discussed here is the necessity of continuous and intensive consultation with stakeholders for any policy plans. This follows from the idea that collective problems should be addressed bottom-up, with solutions and policies emerging bottom-up over time. Continuous and intensive consultation with stakeholders, Colander and Kupers argue, is an essential aspect of such bottom-up approaches (even though the result of such consultation may at times be a proposal for top-down intervention if—and only if—a problem absolutely needs to be addressed but a bottom-up approach is not possible or not likely to yield positive results).

2.3.3 Further remarks about the complexity frame

A number of things should be noted about the complexity frame proposed by Colander and Kupers. First, though the previous section discussed some particular policy examples, Colander and Kupers repeatedly emphasize that they do not aim to argue for particular policies, but for adopting their complexity frame. Adopting this frame does not mean that there will not be disagreements about what policies or policy goals to pursue; it means that what particular policies should be adopted is something that—unsurprisingly—should emerge bottom-up.

Second, Colander and Kupers do not claim that the standard frame is all wrong, with the complexity frame providing the sole truth. Instead, they argue that the complexity frame should be part of the public policy debate. Which frame should be preferred in any particular public policy debate depends on the context: the more complex a system, the more likely that the complexity frame is the frame to go with.

[17] Though 'basic government' needs to be funded via taxes, see Colander and Kupers (2014) p. 239.

Third, it should be noted that in order to apply the complexity frame it is not necessary to have a sophisticated and well-established science of complex systems (though of course it would be useful). For instance, Colander and Kupers argue that the classical economists used several ideas and concepts in the context of policy that fit well in the complexity frame, even though they did not have concepts from complexity science available. Evidently, having tools and concepts from complexity science would be a great help for complexity policy, and although Colander and Kupers have high expectations of complexity science in this regard, they also note that "it just is nowhere near mature enough to provide sufficient concrete guidance yet" (Colander and Kupers, 2014, p. 58).

A last remark concerns whether adopting a few complexity tools but remaining in the standard frame might not be sufficient for policy makers, as Krugman argues (Colander and Kupers, 2014).[18] While this would at least be a step in the right direction, it does not suffice. The central ideas and issues in the standard frame are simply too opposed to those in the complexity frame—for instance 'controlling the system', implying a focus on outcomes of the system, versus 'positively influencing the evolution of the system', implying a focus on the dynamics of the system—, hence concepts from the different frames usually do not sit easily together. Also, given that the standard frame is not disposed of, adding the complexity frame to the set of alternative frames available for public policy only expands public policy options. Inter alia for this reason, it is unclear why one would prefer incorporating complexity elements in the standard frame instead of adding the complexity frame to the set of available frames.

Colander and Kupers (2014, p. 182) provide a useful overview of main changes in how one views public policy when one starts looking at it through the complexity frame instead of through the standard frame. This overview is added to this thesis as appendix A.

2.4 Kirman's perspective on complexity and public policy

At this point, it is worth having a look at a rough outline of how Kirman (2016) perceives the complex system of society and the role of policy makers therein (based on his 2016 review essay of Colander and Kupers (2014), to which we will return in the fifth chapter). Kirman agrees with Colander and Kupers that society (and the economy) is a complex evolving system, which requires a shift in how we think about (policy making in) this system. However, Kirman takes a more radical position than Colander and Kupers regarding how we should think about the complex evolving system of society. The fundamental problem that Kirman identifies with Colander and Kupers' proposal is that they, similar to general equilibrium theorists, assume that society self-organizes around one or another basin of attraction. According to Kirman, this assumption of self-organization—which is absolutely crucial for the standard general equilibrium models that prevail in contemporary economics—is more the result of liberal ideologies than of sound science, for "we have never been able to show that economic systems, even under the rigorous assumptions that we impose on the individuals in the system, will

[18] In line with some economists arguing that concepts and tools from complexity science are a mere addition to mainstream economic theory, see e.g. Blume and Durlauf, 2006; Durlauf, 2012 (Kirman, 2016).

settle to any steady state at all" (Kirman, 2016, p. 536). In particular, Kirman defends the idea that there may not be *fixed* basins of attraction; instead, basins of attraction may evolve with the evolution of the system. Identifying those evolving basins of attraction is usually not possible, Kirman argues, hence our economic models and theories and our approach to policy making should not rely on the possibility of identifying and choosing desirable basins of attraction. Trying to nudge the system to more desirable basins of attraction through influencing people's preferences or norms and adopting adequate ecostructure policies—as Colander and Kupers (2014) propose—is in that case not a sensible thing to do, for there exist no (fixed) basins of attraction in which the dynamics of the economy (or of society) come to rest.

Nevertheless, Kirman suggests that improving our understanding of the economic system may be possible if we engage in careful and detailed observation of the economy. This way, if successful, we may get some idea about the likelihood of the emergence of certain (types of) patterns, transitions between those patterns, and perhaps, ultimately, we may be able to make probabilistic statements about possible trajectories of the economy. Policy makers, Kirman claims, should then constantly observe the system and, where possible and desirable, try to positively influence the evolution of the system—without trying to identify and nudge the system towards desirable (and fixed) basins of attraction.

2.5 Conclusion

This thesis chapter aimed to present the complexity frame introduced by Colander and Kupers (2014). To this end, it gave an overview of some characteristics of complex systems, after which it described why Colander and Kupers deem the so-called standard policy frame—proponents of government interventionism versus proponents of laissez-faire—insufficient. Reasons for this include the impossibility of controlling the evolving complex system of society (an argument against government interventionism), the need for a more facilitating role of the government (an argument against laissez-faire), the failure of the standard frame to recognize the endogeneity of the government, and the lack of recognition on behalf of the standard frame with regard to essential features of complex evolving systems. The chapter continued by describing the complexity frame proposed by Colander and Kupers, which roughly speaking consists of, on the one hand, a focus on ensuring the survival of the system, and on the other hand a focus on positively influencing the system. Main concepts of the complexity frame include diversity (which helps to stabilize the system), a trade-off between local efficiency and global resilience, ecostructure policy (tweaking the rules of the game, influencing the evolution of institutions, and nudging the system towards desirable basins of attraction), and norms policy (people exercising self-control via governmental institutions). Furthermore, this chapter shortly discussed Kirman's perspective on the complexity of the economy and what this implies for public policy, based on his review essay (2016) of Colander and Kupers (2014).

The main take-away of this chapter should probably be the insight that there are public policy issues or areas where the complexity frame can provide (more or less) new and more useful tools and concepts compared to the standard frame. Indeed, the complexity frame provides a different way of thinking about public policy, one that recognizes that the object of public policy is a complex evolving system that cannot be controlled; it can at most be influenced.

Chapter 3

Perspectives from Uncertainty Management

Prepare for the worst; the best can take care of itself.
—Yiddish Proverb

3.1 Introduction

An "*investigation of opacity, luck, uncertainty, probability, human error, risk, and decision making when we don't understand the world*" is how Nassim Nicholas Taleb characterizes his series of (so far) five books called the *Incerto*.[19] Drawing on his experience as an option trader, his philosophical-intellectual interests, and his academic work, Taleb embarks on an iconoclastic tour de force discussing and applying his ideas concerning so-called 'wild' uncertainty and rare, high-impact events to real-world issues. What perhaps characterizes his work best is the focus on exposure to uncertainty, instead of a focus on uncertainty itself. For instance, in his *The Black Swan*, Taleb (2010) deals with what he calls the degradation of knowledge in the context of rare high-impact events. The idea is that we cannot predict such events, hence we should focus on our exposure to those uncertain events (that is, how much we can be affected by those events). Exposure to uncertainty is also central in *Antifragile* (Taleb, 2012), where he draws on the idea that some systems or entities benefit from exposure to disorder, whereas others are harmed by it (or are not or hardly affected). What this disorder exactly consists of is not Taleb's immediate concern; instead it is about the effect of this disorder on the system or entity of interest. Also, 'disorder' here should be interpreted in a broad sense, as it includes uncertainty, variability, imperfect or incomplete knowledge, chance, chaos, volatility, entropy, time, the unknown, randomness, turmoil, stressor, error, dispersion of outcomes, and unknowledge (Taleb, 2012, p. 13). While those are clearly not the same things, at least for the purposes in the *Incerto* they are equivalent in their effects (or so Taleb claims). Furthermore, the switch from the alleged contemporary focus on uncertainty itself to a focus on exposure to uncertainty is most relevant in domains in which a single observation can have a significant impact on the aggregate, which is the case for so-called *fat-tailed* domains (as opposed to *thin-tailed* domains). Consider, for example, academic citations: for a given author, a small number of publications may be responsible for most of the received total citations—hence academic citations are fat-tailed. If academic citations would have been thin-tailed, the number of received citations per published paper would lie around the average number of citations for all published papers of a given author, plus or minus some small deviation—but no outliers.

[19] See http://www.fooledbyrandomness.com/

This thesis chapter aims to present Taleb's argument for focusing on exposure to uncertainty and a selection of implications that seem most relevant to policy makers. The argument for focusing on exposure to uncertainty is mostly based on *The Black Swan* (Taleb, 2010), whereas most implications are based on *Antifragile* (Taleb, 2012). Similar to translation, every representation is also an interpretation. Though this seems trivial, it deserves some attention here for the following reason. Taleb perceives of his *Incerto* as a collection of personal essays, not as a piece of scientific work or a philosophical treatise. The proper support for claims made in the *Incerto* can be found in an online technical appendix and in the academic work of Taleb and some collaborators.[20] This thesis chapter sits somewhere in the middle between the technical appendix and the personal essay-style *Incerto*, for it aims to present a conceptual framework distilled from the *Incerto*. As a result, there may be some more interpretational issues than is commonly the case. At the same time, the odds of interpretations of Taleb's work differing considerably from each other are not too high given that the argument that Taleb uses is quite simple and straightforward. Nevertheless, given this somewhat unusual background this issue is worth mentioning here.

The structure of this chapter is as follows. Section 3.2 discusses Taleb's argument for focusing on exposure to uncertainty—in particular on so-called (anti)fragility and robustness—instead of on uncertainty itself. Section 3.3 then discusses Taleb's proposed (anti)fragility and robustness thinking and implications of this way of thinking that seem most relevant for policy makers, along with some further implications of Taleb's claims and way of thinking that seem relevant for policy makers. The last section concludes.

3.2 From Black Swans to (anti)fragility and robustness

Before discussing the argument in favor of focusing on exposure to uncertainty, it is useful to discuss the concept of Black Swan events in more detail. This is what section 3.2.1 does. Section 3.2.2 continues to discuss how Taleb uses the Black Swan problem (along with some other arguments) to argue against trying to predict and in favor of focusing on exposure to uncertainty when facing fat tails.

3.2.1 Black Swans

The title of Taleb's *The Black Swan* refers to a class of events where each event is defined by three characteristics: an event is a Black Swan if (1) it is an outlier, (2) it has a huge impact, and (3) it seems predictable in retrospect. Taleb sees his Black Swan problem as the practical extension of the familiar logical-philosophical problem of induction. Whereas the problem of induction is concerned with the validity of knowledge claims that are based on inductive reasoning, the Black Swan problem is concerned with the *effects* of this problem of induction in the presence of Black Swan-possibilities. But let us not get ahead of ourselves and first focus on what Black Swan events are.

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[20] The online technical parallel version of the *Incerto* is called *Silent Risk*, and can be retrieved from http://www.fooledbyrandomness.com/

The first characteristic of a Black Swan—that it is an outlier—means that it lies outside the realm of expectations. Whose expectations, one may ask? That depends, for Taleb argues that probability and uncertainty are subjective. Whether an event is a Black Swan is thus relative to the relevant agent. This can be illustrated by the story of the turkey at Thanksgiving.[21] Suppose that a butcher buys a turkey and feeds it for, say, a thousand days. The turkey, having above-average intelligence, recognizes the feeding pattern (say twice every day) and, based on a thousand days of experience, feels safe in extrapolating this pattern to the future. However, as it turns out the one-thousand-and-first day is Thanksgiving, and the turkey's extrapolation of the feeding pattern turns out to be severely flawed: it gets butchered for Thanksgiving dinner. Whereas the butchering is an event that lay outside the realm of expectations of the turkey, the butcher clearly saw the event coming—indeed, it was his intention all along. For the butcher, the slaughtering of the turkey is not a Black Swan, though for the turkey it is (or, for now, it has the first characteristic of a Black Swan event for the turkey).

Black Swan events are also characterized by their huge impact. This characteristic is clear in the turkey example, for the turkey does not survive being slaughtered. Note that, even for Black Swan events, this is somewhat extreme; the impact of a Black Swan does not necessarily entail the non-survival of a system or entity. In any case, a Black Swan event, by definition, does significantly affect the functioning, development, or the like of a system or entity. A number of real-world examples of such Black Swan effects will be discussed throughout this chapter. For now, note that this characteristic is also subjective, or perhaps more precisely, observer-dependent:[22] though the impact of the slaughtering on the turkey is massive, the impact of the slaughtering on the butcher is rather small.

Black Swan events seem predictable to us in hindsight, an effect of our human brains functioning as explanation machines (or so Taleb (2010) argues). This characteristic may not be most clear in the turkey example, though one could think of other turkeys figuring out particular characteristics of the slaughtering butcher and using it as an explanation for why the butcher slaughtered the turkey (thereby missing out on the structural problem of the annual occurrence of Thanksgiving). But retrospective predictability seems a rather peculiar characteristic of Black Swan events. Though Taleb (2010, 2012) has a number of insights in the workings of the human mind in Black Swan- and alike contexts, it seems quite conceivable that a Black Swan event that does not seem explainable or predictable in hindsight could occur. Furthermore, whether we should take the occurrence of Black Swan events seriously, it seems, should not depend on whether a Black Swan is retrospectively predictable—though the apparent predictability in retrospect may delude one into thinking that the event was predictable after all, or that we may be able to predict the next big event, which may lead us to take Black Swan events less seriously. Given this, at least for this chapter we may treat retrospective predictability as a common but not necessary characteristic of Black Swan events.

Time to have a look at a real-world example. An obvious candidate is the financial crisis of 2008. Did it lay outside the realm of expectations? It certainly did, and not for the least

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[21] See Taleb (2012), p. 93, who in turn bases it on a metaphor by Bertrand Russell

[22] Observer-dependent may be more precise since it is not about some subjective representation of the impact, but about who 'gets hit' by the impact

relevant persons and organizations. Makridakis, Hogarth, and Gaba (2009) document the drastic change in attitudes towards the then-current state of the economy among some US politicians and the IMF. For instance, in mid-March 2008, the US Secretary of Treasury proclaimed that he had "*great, great confidence in our capital markets and in our financial institutions*", and continued to praise the strength, resilience, and flexibility of those institutions. Some six months later, the same Secretary of Treasury said that "*The market turmoil we are experiencing today poses great risk to US taxpayers*". The market turmoil of 2008 clearly did not lie in his realm of expectations. The IMF did not fare much better. While they did report (per April 2008) on problems in credit markets in 2007 and expected growth to mildly slow down in 2008, the expectation for 2009 was a recovery. However, by October 2008 the IMF talks about "*the most dangerous financial shock in mature financial markets since the 1930s*". The 2008 crisis was a Black Swan for the IMF as well.

Whether the 2008 crisis had a huge impact is a question that needs little discussion. Enormous government bail-outs, bankruptcies of banks deemed too-big-to-fail, upward surges in unemployment rates, are but a few of the consequences of this crisis.

Retrospective predictability is certainly a characteristic of the 2008 crisis. A decent amount of literature has been produced on the causes of this crisis, examples of which include Diamond and Rajan (2009) and Rose and Spiegel (2010). Given the doubts about the necessity of this claimed Black Swan characteristic, we will not discuss this further.

The 2008 crisis is thus a clear example of a Black Swan event—for many it lay outside the realm of expectations, it had a huge impact, and we can find claims of retrospective predictability in the literature. By now, one may have developed a distaste for Black Swan events and their destructive effects on, in the examples, the financial system and the turkey. While this distaste is certainly justified to some extent, the impact of a Black Swan event need not be negative; it only needs to be huge in order to count as a Black Swan. An example of a Black Swan with (at least some) positive effects would be the spread of the internet: this spread had not been foreseen, and it has an on-going impact on our lives by enabling flexible (mass) communication, increasing accessibility of information (both true and false information), and catalyzing globalization processes, to name a few. Does the spread of the internet seem predictable in retrospect? Presumably, people will differ in their answer to this question, though my conjecture would be that most will tend to say that the spread of the internet was truly unpredictable. While this may or may not be true, it does illustrate once more that retrospective predictability does not seem to be a necessary characteristic of a Black Swan event.

3.2.2 Why we cannot predict: Black Swans and other problems concerning prediction

This subsection distils and discusses Nassim Taleb's argument in favor of focusing on exposure to uncertainty in his *Incerto*. Roughly speaking, the argument aims to establish that in some contexts we face a type of uncertainty that does not allow for reliable predictions. Given that in coping with uncertainty we can either try to predict what will happen or prepare for what might happen, it follows that when facing such uncertainty, we should be prepared for what might happen. Taleb's proposal to focus on the (anti)fragility or robustness of systems is based on this idea of being prepared for what might happen, or in other words, base decisions on exposure to uncertainty.

Given this, we should first assess whether it is indeed the case that we face a type of uncertainty that does not allow for reliable and useful predictions. The main argument that Taleb uses in his *Incerto* to support this claim is based on Black Swan possibilities. We have already seen that, by definition, Black Swan events are unexpected and carry a huge impact. It then follows that to the degree that such unexpected high-impact events play an important role in the aggregate, dealing with uncertainty by prediction cannot be expected to be very fruitful or reliable in the aggregate. For instance, consider trying to predict the economic and political developments in the United Kingdom per the beginning of 2016 for the upcoming four years: missing out on predicting the Brexit (a Black Swan event) would render all predictions unreliable and quite useless.[23] The same problem holds of course for predicting economic development some months before the 2008 crisis. Moreover, the possibility of the occurrence of a Black Swan that may threaten the survival of some system or entity—or more generally has a huge (negative) impact—is in itself already sufficient reason to at least add a focus on being prepared for such events, trying to mitigate or soften their impact. That such Black Swan events can occur is clear: we already mentioned the 2008 crisis, the spread of internet usage, and the so-called Brexit; other examples include the fall of the Berlin Wall, the Arab spring, the attack on the Twin Towers, and so on. The overall point, however, is not that individual Black Swan events render individual predictions meaningless; rather, the point is that *in the aggregate*, Black Swan events play the major role. Therefore, seen from the aggregate level predictions are neither reliable nor useful.

Black Swan events occur only in fat-tailed domains (note that strictly speaking, this terminology is not correct)[24]. Though rare events do occur in thin-tailed domain, they cannot significantly affect the aggregate (or otherwise have a huge impact). For instance, it is impossible that in a group of a thousand persons, the weight of a single person in this group meaningfully affects aggregate weight—even if a person weighs three or even four times the average. The same holds for height, income of a dentist, IQ, weight loss (you cannot lose a significant amount of your weight in one day, perhaps except in cases of plastic surgery or amputation), and the result of dice throws, for instance. Usually, the reason that single observations cannot meaningfully affect the aggregate is that there is some limitation to the values that a single observation can take. For instance, height and weight have biological limits; one simply cannot grow fifty meters tall or weigh two-thousand kilogram. Furthermore, the income of the dentist is limited by the number of hours of work he can put in,[25] and the outcome of a dice throw is limited to the very numbers that are on the dice. This is the thin-tailed domain: there are no significant single events or observations, instead the aggregate is dominated by lots of 'small' events that hover around the average and have limits on the extent to which they can deviate from that average. Fat-tailed variables, in contrast, do not have such limits (or we do not know where the limits are, which can be treated as equivalents for all practical purposes). Wealth, for instance, does not have (strict) biological or physical

[23] In-so-far they were useful in the first place, of course, which seems doubtful.

[24] It is not the domain that is fat-tailed, instead probability distributions are fat-tailed; for ease of exposition, the term 'fat-tailed domain' is used in this thesis, which refers to the domain of all variables that have a fat-tailed probability distribution (and similarly for thin-tailed domains)

[25] This assumes that the dentist does not set up franchising possibilities or has employees, which would raise the limits to some extent.

limits, neither does income, number of academic citations, the death toll of an epidemic, the destruction as a result of war, the impact of an environmental disaster, and the consequences of a financial crisis, to name a few.

However, not every fat-tailed distribution will do for Taleb's purposes. Following Mandelbrot (1963), Taleb (2007) distinguishes between 'true' fat tails and other fat tails: 'true' fat tails have a fractal or self-similar property that generates tails that follow a power-law distribution. This fractal or self-similar property can be seen in the example wealth distributions shown in table 3.1:

Individuals with a net worth higher than	*Fraction of individuals under 'true' fat tails*	*Fraction of individuals under thin tails*
1 million	1 in 62.5	1 in 62.5
2 million	1 in 250	1 in 127,000
4 million	1 in 1,000	1 in 14,000,000
8 million	1 in 4,000	1 in 886,000,000,000,000,000
16 million	1 in 16,000	1 in 1.6E+34
32 million	1 in 64,000	*(not computed)*
320 million	1 in 6,400,000	*(not computed)*

Table 3.1 — Wealth distributions under 'true' fat tails and thin tails. The numbers are taken from Taleb (2010), see p. 232-233. The numbers are hypothetical and only meant to illustrate the difference between thin and fat tails.

The self-similarity of the fat-tailed distribution resides in the constant ratio of any two subsequent fractions. That is, the change in the fraction of individuals having a net worth higher than some threshold when changing that threshold is constant: doubling the threshold from one million to two million cuts the fraction of individuals in four (from 1 in 62.5 to 1 in 250), doubling it from eight million to sixteen million also cuts the fraction of individuals in four (from 1 in 4,000 to 1 in 16,000). In contrast, the same fractions of individuals under thin tails do not have a constant rate of decline when doubling the net worth threshold, instead those fractions decline *exponentially* (that is, the rate of decline increases). Because the rate of decline in the fat-tailed probability distribution is constant, extreme observations (such as an individual with a net worth higher than thirty-two million) are possible. In contrast, due to the exponential rate of decline in fractions in the thin-tailed probability distribution, we see that such extreme observations are basically impossible under thin tails. The difference between both distributions is strong: the fraction of individuals having a net worth of more than thirty-two million under fat tails is higher than the fraction of individuals having a 'mere' net worth of more than two million under thin tails. This self-similarity of 'true' fat tails (in that the rate of decline in probability is constant on all scales) is what allows for Black Swan events.

Note that the defining feature of a Black Swan event is thus not that it is rare. Rare events happen in both thin- and fat-tailed domains; the difference is that fat tails allow for rare *high-impact* events. For instance, in the wealth distribution example of table 3.1 observing an individual with a net worth over two million under thin tails has approximately the same probability as observing an individual with a net worth over forty-five million under fat tails. Both observations are equally rare, but the magnitude of the observation is much greater in the fat-tailed probability distribution. In other words, the magnitude of increasingly rare events is limited in thin-tailed domains, whereas there is no such limit (or hardly such a limit or we do not know where that limit is) in fat-tailed domains.

Figure 3.1 graphically depicts the difference between fat-tailed and thin-tailed probability distributions. The dashed line is a thin-tailed probability distribution, the solid line is fat-tailed. The horizontal axis represents a value that a variable can take (such as wealth), and the vertical axis can be understood as depicting the (probabilistic) frequency with which some value occurs (such as the fraction of individuals with a given level of wealth).

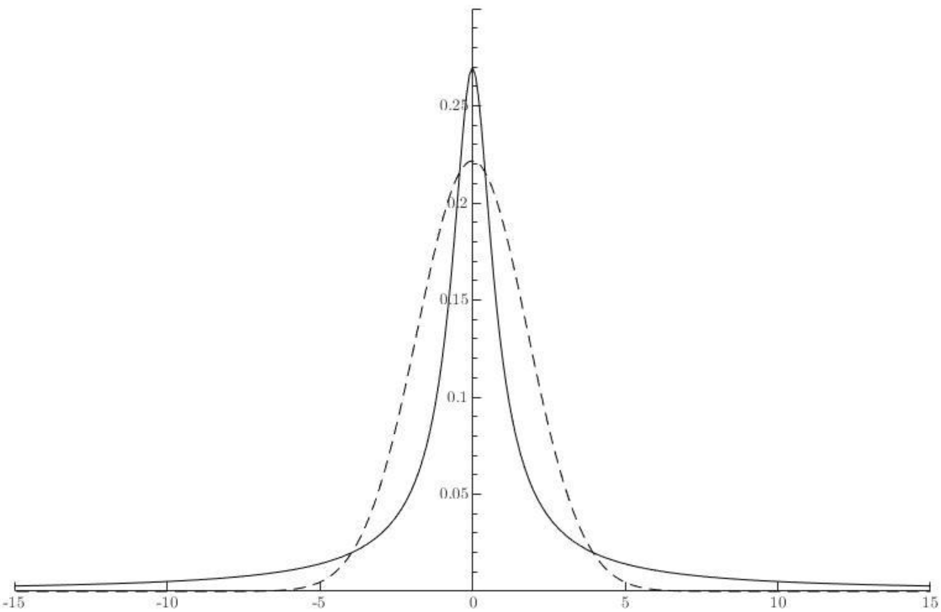

Fig. 3.1 – Thin Tails and Fat Tails. The dashed line represents a thin-tailed distribution (in this case a normal distribution with μ equal to 0 and σ equal to 1.8). The solid line represents a fat-tailed distribution (in this case a t-distribution with 0.5 degrees of freedom). The numbers are chosen based on ease of exposition. The terms 'thin' and 'fat' tails refer to the so-called tails to the (far) left and right of a distribution's peak.

The term 'tails' refer to the far left- and right-hand side of a probability distribution, which is the part that represents rare events. In the graph, we can clearly see that under thin tails, possible values of variables are limited: the thin-tailed distribution (the dashed line) 'touches' the horizontal axis approximately at value six, hence the variable represented here is very unlikely to take a value higher than six.[26] In contrast, the solid line depicting a fat-tailed variable does not touch the horizontal axis at all in this graph—in fact, even at a value of fifty

[26] Though very unlikely, this is not impossible. Technically, (most) thin-tailed distributions tend to zero as they approach infinity. That means that they in fact never touch the horizontal axis. However, the odds of a rare high-impact event occurring under thin-tailed distributions is so infinitesimal (say one in several billions, trillions, or even more—see table 3.1) that we can ignore it: the extremely low probability of such events outweighs the impact of such events (easily). Not so for fat-tailed distributions, where the impact of extreme events outweighs the low (but not extremely low) probability of such events. For technical elaborations, see Taleb's *Silent Risk*, available via http://fooledbyrandomness.com/FatTails.html.

(not shown in figure 3.1), the probability is still equal to 0.000453, a probability that in the thin-tailed domain would roughly correspond to a value of 6.2.

We can relate the numerical example of table 3.1 to the graph in figure 3.1 by focusing on the tail on the right-hand side of the distributions (the left-hand side would correspond to negative wealth—debt—, which likely follows a more thin-tailed distribution). Suppose that the intersection of the solid and dashed line is the first threshold of table 3.1, where under both distributions the fraction of individuals having a net worth of more than one million is equal to 1 in 62.5. Increasing the threshold, i.e. moving further to the right of the graph, we see that the probability of observing a value over this threshold quickly declines under the thin-tailed probability distribution. This corresponds to the quick decline in the fraction of individuals having a net worth higher than some threshold shown in table 3.1. In contrast, the decline in probability under the fat-tailed probability distribution is much slower, corresponding to the much slower decline in the fraction of individuals having a net worth higher than some threshold under fat tails (as shown in table 3.1).

Note also that fat-tailed distributions often have more observations with a value equal or close to the average compared to thin-tailed distributions (given that the fat-tailed distribution has a higher peak at the average than the thin-tailed distribution). The problem with fat-tailed distributions therefore is not that they are more volatile (that is, have more deviations or have a higher frequency of rare events occurring), but that they allow for extreme events such as Black Swans.

Given this, it is important to know which things are fat-tailed and which things are thin-tailed. Distinguishing between thin and fat tails can be done in a number of ways. The two most straightforward ways are 1) by verifying whether a single (micro-)event can have a huge impact on the aggregate and 2) by finding out whether the relevant variable has (biological or physical) limits to the values it can take. [27] Doing so for financial markets, it is easy to see that short episodes of extreme turmoil can (and do) affect aggregates, and there is no principled reason for why, say, a certain stock or an index tracker has a limit on the value it can take (except for going below zero).[28] Of course, policy makers do not only deal with financial markets; they also deal with poverty, intellectual property, sustainability, health, tax, education, and infrastructure, amongst (many) others. Assessing and discussing which policy areas seem to be (mostly) fat-tailed is unfortunately outside the scope of this thesis.

Nevertheless, the evidence supports the more general claim that economic variables are usually fat-tailed. For instance, Makridakis and Taleb (2009) show this to be the case for the Dow Jones Industrial Average (DJIA) and for the stock prices of Citigroup over the period of several decades. Taleb (2009b) presents empirical evidence showing that in general, economic variables such as currency rates, financial assets, interest rates, and commodities are patently fat-tailed. Most of economic (and in particular financial) activity hence seems to take place in

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[27] There are some more ways of distinguishing between thin- and fat-tailed domains, including looking at scalability (fat-tailed variables are scalable), the rate of decrease in probability of an increasingly rare event happening (exponential under thin tails, constant under fat tails), whether something has a fractal, or self-similar, nature (not the case in thin-tailed domains) and whether there is something like a ‘typical’ event or entity (not the case in fat-tailed domains).

[28] An index tracker tracks the total value of a stock exchange (e.g. the Dow Jones or the Amsterdam-based AEX).

fat-tailed domains. Whether this is the case for socioeconomic variables more generally cannot be assessed here, though Taleb claims that this is the case. Demonstrating this is however not crucial for the purposes of this thesis chapter; it suffices to show that there is in fact this type of fat-tailed uncertainty that does not allow for reliable or fruitful predictions, with the implication that whenever policy makers face such fat-tailed uncertainty, Taleb's argument in favor of focusing on exposure holds.

Besides the Black Swan problem, there are other issues that make predictions in fat-tailed domains unreliable. One issue is that many fat tails are caused by complex systems, the unpredictability of which is well documented (see e.g. Arthur, 2015; Kirman, 2016). Another argument is based on the unpredictability of technological progress, which in turn implies a wider unpredictability given that the state of technology is an important factor that influences what happens in much broader contexts.[29] Track records of predictions and empirical studies also show severe difficulties surrounding prediction (see e.g. Tyszka and Zielonka, 2002; Makridakis and Hibon, 2000; Tetlock, 2005). What makes the issue even worse is that the uncertainty surrounding predictions cannot be assessed in fat-tailed domains, for three reasons (Makridakis and Taleb, 2009). First, errors are often not independent, lack a constant variance, and do not follow a normal distribution. As a result, the variance is a very unsatisfactory measure of potential errors, which, given that the uncertainty surrounding a prediction is based on this variance, implies that we cannot assess this uncertainty. Second, the possibility of Black Swan events invalidates any single measure of uncertainty given the huge impact of such events. The third reason is that outside games and artificial set-ups, it is often unknown what the relevant probability distribution is. This uncertainty about the probability distribution translates to uncertainty about the uncertainty surrounding predictions.

This establishes that in domains characterized by fat-tailed uncertainty, we should give up on trying to predict. Instead, we should focus on the other way of dealing with uncertainty, namely being prepared for uncertainty. How? By understanding the (anti)fragility and robustness of systems and implications thereof (or so Taleb argues).

3.3 How to deal with fat-tailed uncertainty

3.3.1 The Triad: fragility, robustness, antifragility

The fundamental idea behind Taleb's proposal on how to deal with uncertainty is that systems or entities can respond in different ways to volatility and disorder. More precisely, there are systems that are harmed by disorder, systems that are not or hardly affected by disorder, and systems that benefit from disorder—respectively labelled fragile, robust, and antifragile systems, collectively labelled *the Triad*. This idea is the reason that the title of this thesis chapter refers to *uncertainty* management, not *risk* management. Risk management can be seen as trying to reduce or prevent harm due to uncertainty or disorder, whereas Taleb's stance

[29] Formally, this is a weak form of the law of iterated expectations that is used in statistics. Taleb phrases it as follows: "to understand the future to the point of being able to predict it, you need to incorporate elements from this future itself" (2010, p. 172).

is more aggressive: “you want to use [randomness, uncertainty, and chaos], not hide from them” (2012, p. 3). This subsection discusses the concepts of antifragility, robustness, and fragility in some detail and looks at a selected number of implications that seem most relevant for policy makers. But first we discuss some simple examples of the Triad based on ancient mythology and on the contemporary business world.[30]

If the sword of Damocles hangs over your head, you are not in an enviable situation: the horsehair holding the sword will eventually break (and disorder increases the chances that it breaks), resulting in significant damage or even a fatality. This is an example of a fragile situation for the person sitting under the sword. Another myth, that of the bird Phoenix, is an example of robustness: whenever Phoenix gets destroyed, it gets reborn again. Therefore, Phoenix is not affected much by disorder. Hydra, on the other hand, is a serpent-like creature that has the peculiar property of growing back two heads whenever one is chopped off. This is antifragility: disorder (chopping of one head) has beneficial effects (growing back two heads). Clearly, one should prefer being Hydra to being Phoenix, and being Phoenix to being under the sword of Damocles.

Translating the concepts to more modern environments, an example of fragility would be our current banking system. Shocks, such as bankruptcies during the 2008 crisis, threaten the whole banking system and result in significant damage. In Silicon Valley, in contrast, bankruptcies do not affect the system as a whole. Indeed, bankruptcies provide information to the remaining firms (and firms-to-be) as to what does or does not work, thereby improving the system as a whole. Silicon Valley is thus antifragile; it benefits from disorder. A sector that represents robustness could be the sector of bakeries. Bankruptcies will not affect the sector negatively but are also not likely to lead to (significant) improvements. The bakery sector, therefore, does not care too much about disorder.

Four important features of the Triad fragility-robustness-antifragility should be noted. First, fragility, robustness, and antifragility are each relative to the source of disorder. A grandmother may be fragile to physical violence but robust to emotional violence; likewise, Silicon Valley may be antifragile with respect to bankruptcies, but fragile with respect to electricity outages. Second, a system or entity can only be robust or antifragile up to a point. Silicon Valley may be antifragile to bankruptcies, though it would likely be harmed—or at least would not benefit—if, say, 80% of all firms located in Silicon Valley defaulted at once. Similar for robustness: a boxer may be robust to physical shocks, but a decently sized boulder would still crush her instantly. Interestingly, this only works one way: throwing a teacup with extraordinary power on the ground does not benefit the teacup (i.e., it does not become antifragile), nor would the teacup care much less compared to the case where it falls on the ground (i.e., it does not become robust): in both cases the teacup simply breaks. Third, the Triad comes in degrees. In other words, one thing can be more antifragile (or fragile) than another thing, it can benefit (or be harmed) more from a given source of disorder compared to other things. Fourth and last, (anti)fragility and robustness are all current properties of systems or entities, unlike risk, which aims to measure or estimate some future state or event.

Finally, an important thing to note about antifragility is that it usually requires fragility of underlying elements. That is, the antifragility of the system usually comes at the cost of the

[30] The mythology examples are taken from Taleb (2012).

fragility of the entities within that system. Consider, for instance, the Silicon Valley example: individual firms are fragile and can hence go bankrupt; such bankruptcies provide information to the other entities in the system as to what does or does not work (predominantly about what does not work) and as such form the source of Silicon Valley's antifragility. The evolutionary process is another clear example: individuals are fragile (they die), but the overall process benefits from randomness and disorder both in the environment and in genetic mutations.[31]

3.3.2 Implications of the Triad

There are a number of further aspects concerning the Triad, which can best be identified and understood by discussing implications of thinking in terms of (anti)fragility and robustness.[32] The implications discussed here are based on claims that Taleb makes throughout his *Antifragile*. Given the focus of this thesis on public policy, not all implications are relevant. Hence, the implications presented in this chapter are a selection of all implications that can be identified.

One implication is that we should not always aim at eliminating randomness, for two reasons. The first reason follows directly from the idea that there are systems that can benefit from certain sources of randomness, for eliminating randomness in such cases would prevent that system from benefiting from this randomness. The second reason is that eliminating randomness does not always eliminate randomness. This seemingly paradoxical statement is based on the idea that constraining thin-tailed randomness tends to produce fat-tailed randomness. In other words, the idea is that mitigating thin-tailed randomness merely 'hides' risks even though (fat-tailed) tensions build up 'under the surface'. A clear example of this is the case of forest fires, where preventing smaller (and locally constrained) forest fires from happening (thin-tailed randomness) results in a higher concentration of flammable materials in a forest which in turn increases the risk of much bigger forest fires (fat-tailed randomness).[33]

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[31] This may correctly remind one of Schumpeter's notion of creative destruction. Taleb argues that the differences between his ideas and Schumpeter's creative destruction are, first, that Schumpeter's notion is not based on statistical properties of fat-tailed domains and (big) asymmetries in payoffs, and second, that Schumpeter did not understand this in terms of layering—as Taleb calls it here—evolutionary tensions (which should probably be interpreted as variation and selection processes on multiple levels—see also Taleb, 2012, p. 193).

[32] It should perhaps be noted that the implications discussed here are based on the assumption that antifragility is better than robustness is better than fragility—for who would rather be exposed to harm than to gains?

[33] As to the argument that preventing all small fires necessarily prevents all big fires: this is true only if *all and every single* small fire can be prevented, which is close to impossible. Moreover, the point is that the current concentration of flammable materials in the forest determines the probability of big fires developing, with the current concentration of flammable materials being determined (in part) by the occurrence of small forest fires. In other words, small forest fires cause subsequent small forest fires to be locally constrained due to the insufficient concentration of flammable material (which results from previous small forest fires); absence of small forest fires causes subsequent forest fires to not be locally constrained due to higher concentrations of flammable material (hence opening up the risk of bigger forest fires). This can also be related to the idea that under fat tails, rare events are less common (less

Government bail-outs of companies can be seen as an analogous example, given that this may lead to prolonged life for inefficient companies. This in turn can lead to a higher concentration of inefficient companies, which is in general undesirable but can even lead to disastrous risks if in a sector with systemic importance—such as the financial sector—the share of inefficient companies increases. Note that for antifragile systems it may not be a bad idea to try to profit from fat-tailed randomness, given that payoffs in under fat tails are much higher than under thin tails (although one should be careful: recall that a system can only be antifragile up to a point). From this it also follows that optimizing systems is not always desirable, given that the optimization of a system often aims at eliminating randomness.

Furthermore, the occurrence of rare high-impact events in fat-tailed domains implies that redundancy is an indispensable risk management strategy, for it helps to absorb (most of) the impact of such events. In other words, it decreases one's exposure to negative Black Swans. Redundancy can take different forms; one straightforward form for governments, companies, and other organizations would be to have redundant liquidity, that is, readily available financial means that are not necessary for day-to-day operations or planned future operations. Arguably, if banks had incorporated redundancy in their risk management strategies the effects of the 2008 crisis would have been (much) less severe. The other side of the coin is that debt is something that should be avoided: debt is the opposite of redundancy, as it limits one's capacity to absorb shocks.

Thinking in terms of (anti)fragility and robustness also implies that bigger is not better in fat-tailed domains, as it tends to fragilize systems. This implication can be related to the already present idea in economics of 'too-big-to-fail' companies. The conclusion drawn from this idea often is that we should not let such companies fail. In contrast, the conclusion that Taleb draws is that we should not let companies become too big to fail. Related to this is the implication that we should enforce *skin-in-the-game*, meaning that the entity that executed a certain action should be exposed to both the negative and the positive possible consequences of this action. Too-big-to-fail companies do not have sufficient skin in the game if they know they will be bailed out by governments in case something goes wrong. Enforcing skin in the game can thus be seen as an attempt to mitigate the effects of agency- or free-riding problems. The lack of skin in the game in cases of too-big-to-fail companies is particularly worrisome given that in those cases the 'upside', or potential positive payoffs, accrue to the private sector, whereas the 'downside', the potential negative payoffs, are borne by the public sector (at least in cases where such companies risk bankruptcy). Besides this being a serious ethical problem, the lack of disincentives here also stimulates taking on more risk given that the downside is borne by the public sector (at least in severe negative consequences such as (near-)bankruptcies). More generally, lack of skin in the game is worrisome because it prevents learning from mistakes. Mistakes usually result in some kind of negative payoff, which can be seen as informing one that a certain action was a mistake. If an entity mistakenly executed a certain action, lack of skin in the game prevents this negative payoff from harming the entity, due to which the entity may not realize the mistake and thus may not act in order to prevent such mistakes in the future (in other words, does not learn).

forest fires occur if small ones are prevented), but those that occur have a huge impact—see section 3.2.2.

The implications discussed so far seem mostly defensive, trying to prevent or mitigate fragility or trying to deal with wild randomness that has potentially severe negative consequences. Besides those defensive implications, however, there are also more aggressive implications, i.e. implications that aim to profit from uncertainty. In particular, Taleb argues that the way to profit from antifragility is to use *optionality*. This strategy is similar to buying options in the financial market: there is a relatively small cost (purchasing the option) but a potentially very large returns due to fat tails. Most likely, a large share of the options will not yield very large returns but will fail to deliver anything or only bring very small benefits. This is not a drawback, for losses are limited to the initial payments; negative Black Swans are thus excluded. Positive Black Swans, however, are not excluded, and one positive Black Swan can offset a large number of small losses. Hence, the idea is to expose oneself to as many positive Black Swan possibilities as possible while keeping potential losses limited. It is important to note that there is no need to predict or identify a particular positive Black Swan, it suffices to identify the *possibility* of a positive Black Swan. For instance, one does not need to predict the growth pattern of a start-up in order to identify it as a Black Swan possibility, one only needs to verify whether it is possible for that start-up to become a huge success—and a small probability is sufficient, for the rationality of optionality resides in aggregate, not in individual Black Swan possibilities. Furthermore, optionality relates to redundancy as risk management discussed above, for redundancy is not necessarily defensive. Indeed, having redundant resources enables you to expose yourself to Black Swan possibilities without caring about small losses (the initial payments).

This strategy can be generalized a bit further to the so-called *barbell strategy*. The name is derived from barbells that weightlifters use, which resemble the combination of two extremes (the weights at the end of the barbell). The two extremes that the barbell strategy employs are extreme safety on the one hand, and extreme aggressiveness on the other hand. In the context of trading, this may be fleshed out by investing, say, 90% in very safe assets such as US treasury bonds, and investing the remaining 10% in high-risk, potentially high-reward assets such as options. The idea, again, is to prevent exposure to negative Black Swans by ensuring a known maximum loss while exposing oneself to positive Black Swans. This strategy of focusing on extremes is necessary in fat-tailed domains, but not in thin-tailed domains, where it is often most useful to focus on averages. This difference in usefulness of focusing on extremes versus focusing on averages arises because (as we have seen) extreme observations are limited under thin-tailed distributions, whereas they are practically unlimited under fat-tailed distributions.

3.3.3 Implications of Taleb's general complexity thinking

Some of the ideas discussed in Taleb's *Incerto* are more the result of his general complexity thinking than of (anti)fragility and robustness thinking and are hence discussed separately (and shortly) in this subsection. One idea is that in complex systems, simple rules work better than complicated rules. Complicated rules, Taleb claims, may lead to multiplicative chains of unforeseen effects; those unforeseen effects would presumably be corrected via some intervention that itself may lead to further unanticipated consequences, and so on. Heuristics are Taleb's preferred tool, not because they always work but because the user knows that they are just heuristics, no perfect decision rules.

Related to this is Taleb's opposition to what he calls naïve interventionism, that is intervening without worrying (sufficiently) about unintended side-effects—also called *iatrogenics*, a term stemming from medicine. Given that the socioeconomic system is complex, an intervention may have various unintended side-effects some of which may turn out to do significant damage of some sort. This can often be related to one of the implications discussed in the previous subsection. For example, trying to smoothen the business cycle by interventions (constraining thin-tailed randomness) may lead to sudden large shocks (fat-tailed randomness). An example relating to foreign policy would be the U.S. support for controversial regimes by referring to the need for stability in the region—usually followed by a revolution at some point. In the context of health policy, the idea is that there should be more focus on possible unintended harm that is not easily visible, such as the combined risks of multiple medicines.

Another claim of Taleb is that different levels of government bring different dynamics. Centralized state government behaves very different from and faces very different dynamics than municipalities, for the dynamics at the state level are more complex and more fat-tailed than those at the municipality level. The dynamics at the municipality level are much closer to thin-tailed dynamics, whereas the state level is closer to fat-tailed dynamics. Switzerland, where the predominant part of politics takes place at the municipality level, is taken as an example of how thin-tailed dynamics at the municipality level creates stability at both the municipality and the state level. Though Denmark may at first seem a proper counter example for this claim (given its big role for the state), it in fact supports Taleb's claim: though Denmark has a central state that collects taxes, the spending of the money happens within local communities (or so Taleb (2012) claims).

Lastly, Taleb advocates forced fiscal balance, meant to minimize cost overruns. He notes that the uncertainty regarding the eventual costs of a project is asymmetrical: costs overruns are far more common than costs underruns (and cost overruns are in principle unlimited, whereas cost underruns are limited—a project cannot have negative costs). Moreover, the bigger and more complex a project, the more likely that nonlinearities cause exponential project overruns (which are relatively common). Enforcing a fiscal balance prevents this, simply because the available liquidity is limited.

3.3.4 Turning Black Swans into Gray Swans

One defining characteristic of a Black Swan event is that it lies outside one's realm of expectations. An obvious question then is what we could do to make such an event fall *within* our realms of expectations. While Black Swan events will never become predictable in any precise way, some of them can be *conceivable*—turning them into what Taleb (2010) labels Gray Swans. Despite lacking precision, having an idea of what might happen is useful to prepare oneself for it. For instance, many economists had not even conceived of the possibility of a huge financial crisis happening around 2008: the response of the British Academy to the question of the Queen of England concerning why economist had not seen this crisis coming blamed "the failure of the collective imagination of many bright people to understand the risks to the systems as a whole" (British Academy, 2009). If sufficient economists had thought it conceivable that such a crisis might happen, the impact of the crisis would likely have been less severe. Gray Swans are characterized by Taleb as *Mandelbrotian*, given that the work of

Mandelbrot on fractal randomness is largely responsible for turning a number of Black Swans into Gray Swans.

3.3.5 Non-predictive policy making

One may wonder how non-predictive policy making could possibly look like. Do we not need to predict costs and benefits of a policy in order to see whether the net benefits are positive, or to decide on which policy alternative is the most preferable? According to Taleb, there is however another way, namely measuring the (anti)fragility or robustness of a policy, or perhaps more accurately the (anti)fragility or robustness of the costs and benefits of the policy which then can be added up to end up at the overall (anti)fragility or robustness of that policy.

Figures 3.3, 3.4, and 3.5 depict the concepts of antifragility, fragility, and robustness graphically. An example of thinking about policy alternatives in terms of (anti)fragility and robustness could be the following. Suppose that policy makers have to decide on two alternative infrastructure projects, for which they need to know the potential costs and benefits of both projects. Instead of making a point estimate (that is, a singular estimate of the expected costs) of the costs and benefits of the projects, the policy makers should measure the fragility of the project costs and benefits. The idea roughly is that one measures the exposure of the relevant costs or benefits to a given source of disorder (recall that (anti)fragility and robustness is source-dependent), in other words, to what extent the costs or benefits of a project can be affected by the given source of disorder (and then do so for all relevant sources of disorder). Unlike regular cost-benefit analyses that try to measure or estimate some *future* state, this approach is non-predictive because—as noted before—(anti)fragility and robustness are *current* properties (for one does not need to predict when a teacup will break in order to see that it is fragile).

This raises the question of how (anti)fragility and robustness can be measured, which is answered in a paper by Taleb and Douady (2013) where they develop mathematical definitions and heuristic measurements of (anti)fragility and robustness. Unfortunately, due to the technicality of the paper we cannot discuss this question (and answer) here.

Another type of non-predictive policy making can be found in Taleb's cooperation with the IMF. This cooperation is focused on stress tests that are used to assess the robustness of banks against shocks. A working paper develops a heuristic measure of fragility that provides additional information on the robustness of those stress tests—in particular on the risks of rare high-impact events such as Black Swans (Taleb et al, 2012). The measure developed in this paper is also applied to testing the robustness of levels of public debts against shocks and can generally be applied to various kinds of stress tests.

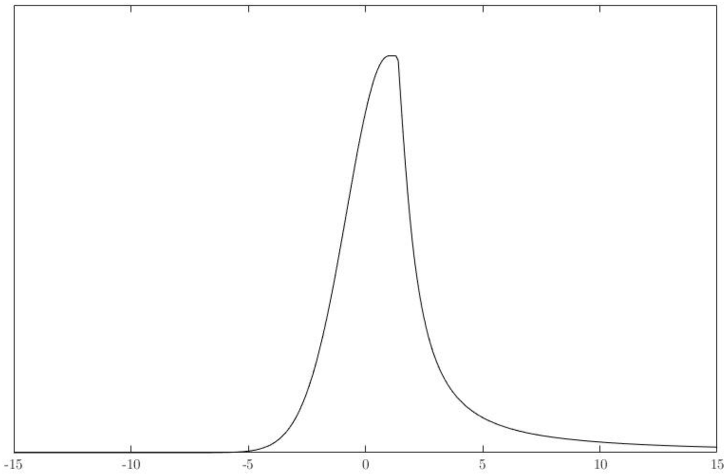

Fig. 3.3 – **Antifragility.** Limited downside, unlimited upside.

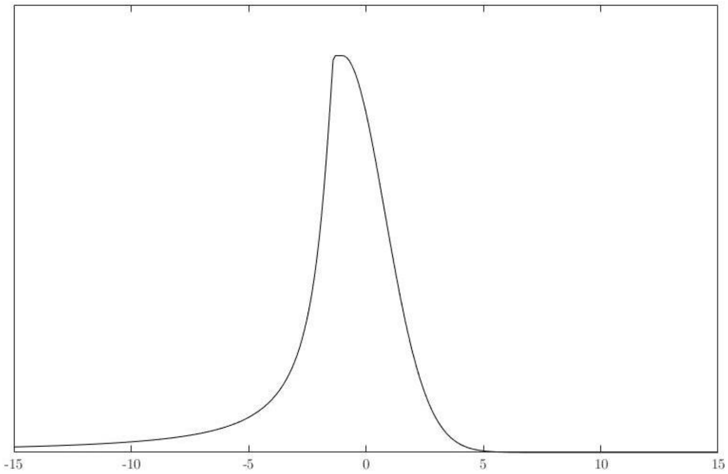

Fig. 3.4 – **Fragility.** Unlimited downside, limited upside.

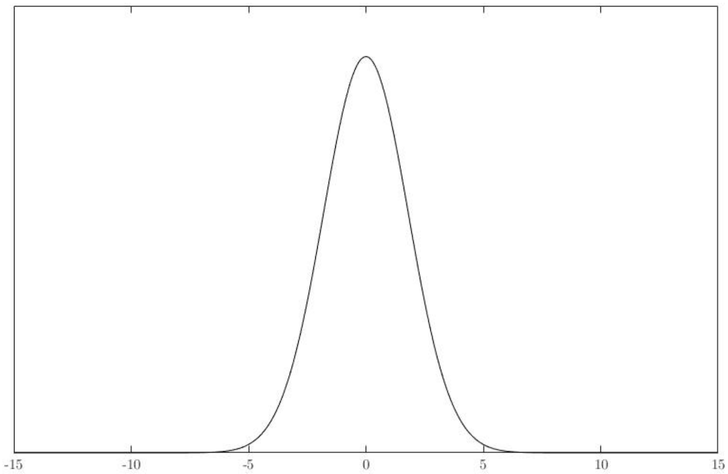

Fig. 3.5 – **Robustness.** Limited down- and upside.

3.4 Conclusion

This thesis chapter presented Taleb's argument against using prediction and in favor of focusing on exposure to uncertainty in fat-tailed domains by means of focusing on the (anti)fragility and robustness of systems or entities. The argument essentially states that due to the possibility of Black Swan events—rare high-impact events—occurring in fat-tailed domains, prediction in those domains is unreliable. It then follows that to deal with uncertainty (amongst which Black Swan events), we should focus on our exposure to uncertainty. Policy-relevant implications of thinking in terms of (anti)fragility and robustness were then discussed, including the idea that randomness can be useful and hence should not always be eliminated, redundancy as risk management, and optionality as a tool for utilizing positive Black Swan possibilities. More generally, the implications of thinking in terms of (anti)fragility and robustness usually revolve around limiting negative exposure (and hence trying to prevent negative Black Swans) and maximizing positive exposure, in particular exposure to positive Black Swans.

Perhaps the main lesson or message of this chapter is that even though making accurate prediction is impossible under fat tails, there are still sufficient non-predictive concepts and tools available that policy makers can use to think about what policies to pursue. Indeed, based on this chapter (and Taleb's work more generally) a plausible argument can be made that using non-predictive methods will turn out to be more fruitful than using predictive methods that seem to have dominated so far.

Chapter 4

Bringing the Perspectives Together

The previous two chapters each introduced and discussed a certain perspective on public policy. The second chapter revolved around public policy as seen through the complexity frame introduced by Colander and Kupers (2014). The third chapter focused on the work of Nassim Taleb—characterized in this thesis as uncertainty management—by distilling and discussing his general argument against prediction and in favor of non-predictive decision making as well as some selected implications of his work (in particular of the triad (anti)fragility and robustness) that seem most relevant for policy makers. The aim of this fourth chapter is straightforward: to bring both perspectives closer together by drawing several connections between the two. This will be done in the subsequent section. Section 4.2 draws a conclusion.

4.1 Connecting uncertainty management and the complexity frame

In order to gain a clear overview of the various connections between the complexity frame proposed by Colander and Kupers (2014) and the ideas concerning uncertainty management by Taleb (2010, 2012), this section is divided in five themes. The first theme discusses the domains of application and shared (general) concepts; the second theme discusses ensuring system survival; the third theme discusses influencing (the evolution of) the system; the fourth theme discusses government structure; the fifth theme, finally, discusses which topics should (not) be key debates in public policy. Lastly, a conclusion is drawn.

Theme I—Domains of Application and Shared (General) Concepts

We noted in the third chapter that fat tails are often caused by complex systems. Taleb (2009a) gives a functional definition of a complex system by identifying three characteristics, namely a great degree of interdependence between its elements, feedback loops that result in fat tails, and nonlinearities that accentuate the fat tails. Thus, all complex systems are fat-tailed. The converse, however, is not true: fat tails do not (necessarily) imply a complex system.

Given this largely shared domain of application, it is no surprise that common themes and concepts are easily identified. For one, both view the economy as a complex evolving system that does not lend itself for top-down control. Both also recognize various characteristics of complex systems such as its interconnectedness and the existence of feedback loops and nonlinearities. The unreliability of prediction in complex systems is a common theme for both perspectives, though for Taleb this is the starting point for looking at exposure to uncertainty, whereas for Colander and Kupers this suggests that we should try to influence the evolution of the system instead of trying to control it (for which one would need predictive methods).

Other concepts or features of complex systems that both make use of are phase transitions (called tipping points by Taleb), the fractal or self-similar nature of certain complex dynamics, emergent patterns, and path dependence. However, not all concepts are shared: Taleb does not use the concepts of (multiple) equilibria, attractors, or basins of attractions; in fact, Taleb (2012) argues that the only situation in which something organic (which includes complex evolving systems) is in equilibrium is in death. Hence, Taleb seems closer to Kirman (2016) than to Colander and Kupers (2014), for both Kirman and Taleb do not use the notion of basins of attraction or some other equilibrium notion as a basis for their further views (or think such things exist or can be identified)—although it must be noted that Taleb does not specifically discuss the notion of basins of attraction.

Theme II—Survival of the System

The second theme concerns the survival of the system. We have seen that in Colander and Kupers' complexity frame, survival of the system comes first (since everything else depends on this). Regarding this, Colander and Kupers discuss diversity as a means to systemic stability (hence contributing to survival) and identify a trade-off between local efficiency and global resilience. Interestingly, both can be related to Taleb's work in quite straightforward ways. The trade-off between local efficiency and global resilience, for example, relates to Taleb's claim that constraining thin-tailed randomness leads to fat-tailed randomness: the example of the just-in-time supply chain in place in the Japanese automotive sector can be read as an attempt to get rid of (thin-tailed) randomness in order to improve efficiency, which led to the vulnerability for Black Swan events such as the tidal waves hitting Japan (hence implying fat-tailed randomness). Furthermore, given that Taleb argues that thin-tailed randomness stabilizes the behavior of complex systems, it seems arguable that diversity is the static mirror image of thin-tailed randomness.

Oddly enough, Colander and Kupers do not discuss the Black Swan problem. Given that Black Swan events can threaten the survival of a system, they should be part and parcel of any perspective on the survival of (complex) systems. Ensuring the survival of a system basically involves trying to set limits to the damage that can be done to that system—either damage due to Black Swan types of events or some other type of damage that threatens the system's survival. One simple but useful 'tool' in this respect is the idea of redundancy discussed in the previous chapter: redundancy enhances the capacity of a system to absorb shocks. Avoidance of debt follows logically from this, given that debt reduces this capacity.

Colander and Kupers discuss the survival of a system in terms of the resilience of a system, defined as "the capacity of a system to absorb and adjust to change by learning from it" (2014, p. 200). Taleb (2012), however, equates resilience with robustness and defines the resilient as something that "resists shocks and stays the same" (p. 3). Resilience as defined by Colander and Kupers seems to go somewhat beyond robustness or resilience as defined by Taleb,[34] though it is not the same as antifragility: the antifragile is exposed to large (unexpected) gains, whereas the resilient 'merely' adjusts to change. It has, however something common with the

[34] 'Resilience' will from now on refer to the definition of Colander and Kupers; for Taleb's definition we will use the term 'robustness'.

antifragile, which is that both (usually) seem to result from learning from disorder by processing the information it contains.

Related to this, Colander and Kupers accept the argument—due to unspecified 'purists'[35]—that resilience, the concept used in the context of survival of the system, cannot be properly measured (though they also claim that this is no reason to dismiss the concept of resilience). Interestingly, we noted before that Taleb and Douady (2013) established proper mathematical definitions of fragility, robustness, and antifragility and propose using robust heuristic measures (instead of less robust optimized and calibrated measures) to measure (anti)fragility and robustness. This, combined with (anti)fragility and robustness being quite strongly related to resilience, implies that at least in certain contexts it is likely that we can use the concepts of robustness and antifragility instead of resilience. For instance, for thinking about the survival capacity of a system the concepts of (anti)fragility and robustness are well suited. At the same time, it should be recognized that though there may indeed be no 'proper' measurement of resilience according to purists, there are measures of resilience available that may capture aspects that the concepts of (anti)fragility and robustness are not built to capture. This is because (anti)fragility and robustness are concepts based on statistics and mathematics, whereas the concept of resilience was originally introduced in ecology to describe the stability of populations (see Reggiani, De Graaf, and Nijkamp (2002)). Hence, resilience and (anti)fragility and robustness may be mostly complementary concepts, both in terms of what exactly they aim to capture and what they can measure.

Although survival of the system is an important priority, it does not mean that we should always aim for the survival of all systems. Though it is evidently desirable for a society to ensure the survival of the overall societal system (in so far one can speak of such a thing), there may be malfunctioning or outdated subsystems within the overall system that in some way negatively influence the evolution of the overall system or other subsystems. For instance, we may not want a system that functions based on environmentally unfriendly practices to survive (if there are no prospects of the system turning away from such practices). Moreover, we have seen that Taleb argues that individual elements in a system may need to be fragile for the overall system to be antifragile. Given that something may be an element from one perspective but a system from another perspective (e.g., the Rotterdam economy is a system consisting of, amongst others, the harbor and the Erasmus University, but can be seen as an element in the system of the Dutch overall economy), this means that subsystems within a system may need to be fragile for the overall system to be antifragile. Without bankruptcies of individual companies, Silicon Valley would not have been where it is now; without the extinction of individual species or mutations, evolution would not have gotten this far.

Theme III—Influencing (the Evolution of) the System

Whereas in the complexity frame of Colander and Kupers positively influencing (the evolution of) the system is a key focal point, Taleb does not explicitly discuss this. Nevertheless, the implications of (anti)fragility and robustness thinking can be understood as aiming to cut off the possibility of (severely) negative evolutionary trajectories of the system and to expose oneself to possible positive trajectories, in particular by focusing on preventing exposure to

[35] See Colander and Kupers (2014) p. 201

negative Black Swans and seeking exposure to positive Black Swans. In this sense, (most of) Taleb's work focuses more on influencing the possible evolutionary trajectories of the system instead of influencing that trajectory itself.[36] This may be a main reason why Taleb does not even touch upon the idea of multiple equilibria or basins of attractions in his work: influencing the possible evolutionary trajectories of a system does not require knowing whether the system has in fact equilibrium tendencies. In fact, one hardly needs to know anything at all about the system at hand to use, for example, redundancy as an instrument for limiting exposure to negative Black Swans—except that it is a system subject to negative Black Swan possibilities. Similarly, one does not need to know much about a system in order to use optionality as a means for exposing oneself to positive Black Swans—except that it is a system subject to positive Black Swan possibilities. Given this, Taleb's work and Colander and Kupers' complexity frame can be seen as complementary: the focus in the complexity frame is on trying to influence the dynamics of the system in such a way that it has a positive influence on the evolution of the system, whereas the focus of Taleb's work is on preventing certain (unknown) trajectories from unfolding and opening up to certain other (unknown) trajectories.

Furthermore, some implications of Taleb's work seem to fit well in Colander and Kupers' idea of laissez-faire activism. Recall from section 2.3.2 that laissez-faire activism is mostly about facilitating the flourishing of bottom-up approaches, with ecostructure policy—influencing the rules that determine the behavior of the system—as a main tool. Those rules can often be understood as replicator dynamics, i.e. simple rules that govern the evolution of a system. This links well to Taleb's argument that what is needed in complex systems are simple rules, not complicated ones: complicated rules are usually top-down implemented rules focused on outcomes or states of the system, whereas simple rules usually focus on the bottom-up dynamics that determine the behavior of the system. One such simple rule that Taleb proposes is that of skin-in-the-game, that is, an entity should be exposed to negative consequences of its own actions and choices. This is a simple rule that influences the dynamics of the system by forcing the entities within the system to learn from their mistakes (or get winnowed out in case of sufficiently severe mistakes).

More generally, Taleb views top-down policies and interventions as fragilizing the system (for instance by removing necessary disorder or due to unintended side-effects) and advocates bottom-up approaches instead. This is evidently in line with Colander and Kupers' focus on facilitating bottom-up approaches and leaving the resulting dynamics to their own. A good example here is Taleb's discussion of Ricardo's concept of comparative advantage, which, Taleb claims, works if specialization has incrementally evolved over time but does not work if it is implemented top-down by policy makers. Hence, according to Taleb "The role of policy makers should be to, via negativa style, allow the emergence of specialization by preventing what hinders the process" (2012, p. 450), in other words, to facilitate a bottom-up realization of specialization. Policy makers should not decide on which sectors or industries should be stimulated (a top-down intervention), instead, they should 'let specialization happen'—and remove obstacles such as lobbying efforts of big corporates that aim at securing the status quo or previous top-down interventions that prevented bottom-up specialization from taking place.

[36] Following the terminology of Colander and Kupers, we might call this meta-meta-policy.

The 'via negativa style' refers to the more general theme of Taleb's *Incerto* that subtraction is more robust (to errors) than addition. In the context of knowledge, for instance, this means that removing wrong knowledge is more robust than adding putatively correct knowledge—analog to how falsification is more robust to errors than confirmation. In the context of policy making, this means that removing obstacles—factors that in some way prevent a positive or sustainable evolution of the system—is more robust to errors than trying to establish an entity or factor that is supposed to positively influence the evolution of the system in some way (where more robustness to errors means being less vulnerable to unintended consequences of the intervention).

This brings us to a possible criticism of Taleb on Colander and Kupers' proposal to positively influence the system: trying to exert a positive influence is more vulnerable to unintended consequences than removing obstacles and let the system run its course. However, one should be careful here, because it is not necessarily always clear whether one is removing an obstacle or adding something new to the system. Recall for instance, the Bogota example, where installing sidewalks in crime-ridden neighborhoods reduced crime rates considerably: is this an addition in the system (because sidewalks are added), or is this the removal of an obstacle (because the absence of sidewalks can be seen as an obstacle for social interaction in the community)? Similarly, is explicitly opening up the possibility for creating for-benefit institutions tantamount to adding a new organizational form to the system, or does it remove obstacles for individuals who in fact want to start such an organization but are hindered by the existing formal framework that determines which organizational structures are possible? More generally, one could argue that a large part of Colander and Kupers' laissez-faire activism consists of removing obstacles, given their focus on *facilitating* bottom-up approaches. Facilitating something, that is, enabling something to start or to happen, seems to necessarily involve the removal of that which prevented this something from starting or happening in the first place. Taking this a bit further, one could even argue that building infrastructure is equivalent to removing obstacles for commuting or travelling more generally.[37] The point here is not to argue that most or all policies in fact remove obstacles from the system, rather, the point is that if one accepts Taleb's argument that removal is more robust than addition in the context of public policy, it is important for policy makers to think about whether they are removing something from or adding something to the system—and they should prefer removing something from over adding something to the system.[38]

Continuing with Colander and Kupers' proposal to study the topography of the system, i.e. to study the natural features and structural relationships that obtain in a system, this may help in what Taleb calls turning Black Swans into so-called Mandelbrotian Gray Swans. Those Gray Swans are near-Black Swans, with the exception that they are not wholly unexpected: they are conceivable (and, in some cases, even somewhat predictable). In turn, once a certain event happening is conceivable, it is easier to prepare for it should the event in fact happen. Moreover, studying whether a system is thin- or fat-tailed, or whether the system is fragile, robust, or antifragile, seems to fit squarely in with the idea that the topography of the system

[37] A particularly clear example would involve drilling a tunnel through a mountain that forms a natural border between two areas. Drilling a tunnel would clearly overcome the obstacle for travelling that this mountain forms.

[38] Indeed, Taleb would most certainly argue that existing policies are mostly additions to the system.

must be studied. Taleb confirms this idea when he states that "it is the system and its fragility, not events, that must be studied" (2012, p. 132) and illustrates this by reference to percolation theory in physics, in which "properties of the randomness of the terrain are studied, rather than those of a single element of the terrain" (2012, p. 132)—indeed a notion that is close to studying the natural features and structural relationships that obtain in a system.

At this point it may be worthwhile to say something about Kirman's position in this respect. The second chapter noted that Kirman suggests that careful and detailed observation of the economy may improve our understanding of it, and we may get some idea about likelihoods of emergence of certain patterns and transitions between them. A first problem that Taleb would raise here concerns the (standard) problem of noise: data usually consists of both information and noise, and it has the property that the shorter the timeframes in which the datapoints are observed, the higher the noise-to-information ratio. Hence, increasing the level of detail in our observations does not necessarily increase the amount of effective information that we get from our observations. Indeed, without somehow filtering out most of the noise, increasing the level of detail in our observations—at least in the sense of shorter timeframes—may cloud our understanding of the economy rather than illuminate it. A second point that Taleb would raise is that all thin-tailed variations and risks in a system should be ignored. One reason for this resides in the information-providing function that those variations have (recall that randomness should not always be eliminated, as discussed in the third chapter). Another reason is that it is simply ineffective to focus on thin-tailed risks or variations, for in socioeconomic contexts the most relevant risks come from the fat-tailed domain. Again, the detailed observation proposed by Kirman may therefore not be very effective, at least with regard to managing risks. Lastly, this also relates to Taleb's more general assertion that interventions in complex systems directly aiming at influencing outcomes are justified only if they aim at preventing or mitigating the effects of negative high-impact events such as financial or political crises, not if they aim to micromanage society or the economy—again, constraining thin-tailed uncertainty leads to fat-tailed uncertainty.

But this is probably too critical, given that Kirman is more radical than Colander and Kupers in dismissing the idea that the economy can be controlled or influenced. Though Kirman does propose 'detailed' observation of the economy, the eventual goal (as discussed in section 2.4) is to try and learn something about the emergence of certain patterns or configurations of behavior on the aggregate level, which may allow us to "make probabilistic statement [*sic*] about the trajectories that the economy might follow" (Kirman, 2016, p. 567). Policy makers cannot do more than constantly observing the system and where possible and desirable try to positively influence the evolution of the system. Those goals and tasks of policy makers are not undermined by the above discussion, hence the above critical remarks should be seen as directed at the usefulness of careful observation of the economy; Kirman's overall proposal does not seem to conflict with Taleb's arguments discussed in this thesis (though Taleb may be more pessimistic about the possibility of formulating probabilistic statements about possible trajectories of the economy, given the role of Black Swans).

Regarding norms policy, Taleb does not say something directly on the topic. However, we can identify, albeit somewhat speculatively, a common mechanism that may underly both norms policy and antifragile thinking, namely the provision and spread of information. We have seen that one reason why a system can be antifragile is because it uses information provided by shocks, and disorder more generally, in order to improve itself. Now recall the example of Bogota (section 2.3.2), where the installment of spacious sidewalks in crime-ridden neighborhoods decreased crime rates considerably, putatively due to the sidewalks enabling people to meet, socialize, and (further) develop certain norms. This example can be read as suggesting that enabling the flow of information—in particular in terms of information about expected behavior—between entities in a system supports the development of common patterns of thought and behavior, perhaps even of something like a common identity which may increase (social) cohesion in the system.

Theme IV—The Ecostructure of Government

A key motivation for Colander and Kupers' discussion of the ecostructure of government is the idea that policy makers should be shielded from (political) pressures by lobbyists and other interest groups that want to influence government policy in order to gain short-run benefits. This issue, they claim, is especially pronounced in the complexity frame given that bottom-up approaches are more time-consuming, whereas interest groups may advocate much less time-consuming (but socially undesirable) top-down interventions. In the third chapter, Taleb argued that governmental institutions at local levels may be more desirable than at state levels given that this leads to more stability. This, however, is not the only advantage; a second advantage that Taleb (2012) notes is that lobbyists cannot really exist in municipalities: influencing government policy at a multitude of local levels would require costly armies of lobbyists, first because of the number of governmental institutions that need to be influenced, and second because of the idea that citizens who are embedded in their communities will be more engaged with decision making at this level. This aspect fits well with Colander and Kupers' discussion of government as a set of overlapping institutions at multiple levels.

Furthermore, a connection qua budget constraints can be identified, for both Colander and Kupers as well as Taleb favor tight budget constraints in order to minimize cost overruns. A minor difference between their positions is that whereas Taleb remains at a more general level by only arguing for general forced fiscal balance, Colander and Kupers tend to zoom in on hardening the budget constraints of particular agencies or governmental institutions.

Theme V—On What Our Debates Should (not) Be About

Colander and Kupers identify the debate on government control versus laissez-faire approaches as the central debate in the standard frame. This, they claim, is not the issue that should be the subject of the debate, given that it follows from complexity thinking that both the government and the market are endogenously evolved institutions that have their function in the overall system. Instead, they propose to turn the subject of bottom-up versus top-down approaches into a key debate in public policy. This proposal is not too far away from Taleb's position, to whom the question of intervention "is mostly about having a systematic protocol to determine when to intervene and when to leave systems alone" (2012, p. 120-121)—though admittedly 'leaving systems alone' is not exactly the same as the bottom-up approaches proposed by Colander and Kupers. Nevertheless, given that under the third theme we saw that Taleb's approach seems to fit well with the laissez-faire activism proposed by Colander and Kupers, it is plausible that both parties would agree to making the question of when to use top-down interventions, when to use bottom-up approaches, and when to do nothing, into a key question for policy makers.

Another key debate for both Taleb and Colander and Kupers is the extent of centralization or decentralization of governmental institutions. This follows from the claim of Colander and Kupers that government is or should be a set of overlapping institutions at different levels, as well as from Taleb's claim that different levels (e.g. the state or the municipality level) bring different dynamics. Hence, a key question for any policy is on what level it should be designed and executed, or more generally, which (governmental) institution at what level is supposed to perform what (kind of) function.

4.2 Conclusion

This thesis chapter connected the perspectives on public policy based on complexity theory and based on uncertainty management, discussed in chapter two and three respectively. The conclusion that can be drawn from this is that although there are differences between both perspectives, most of those differences seem to complement each other. Some disagreements, however, were identified as well. The overall impression that this chapter should leave is that both perspectives go well together and are useful complements regarding doing public policy as an art. At the same time, it should be noted that the connections identified in this section can probably be analyzed at a more fundamental level, which may be a promising avenue for further research.

Chapter 5

Critical Perspectives

This chapter critically discusses the perspectives presented in this thesis. It will do so by first discussing the common criticism leveled at complexity theory that it has not demonstrated anything surprising—a criticism that will likely also be leveled against Taleb's approach. Afterwards, the focus will be on Colander and Kupers' complexity frame by first discussing Kirman's (2016) criticism (section 5.2.1), supplemented by some further critical remarks. Section 5.3 takes on Taleb's approach by trying to find out what one would need to show in order to prove Taleb wrong (and whether that seems possible), along with some further criticisms that can be raised. The last section concludes.

5.1 To be surprised or not to be surprised

In an overview of what has been done in the complexity economics research program, Rosser (1999) reports Horgan's (1995, 1997) criticism on complexity theory (lumped together with cybernetics, catastrophe theory, and chaos theory) that it has not "told us anything about the world that is both concrete and truly surprising, either in a negative or in a positive sense" (Horgan, 1997, p. 232). Furthermore, Horgan (1997) argues that the contribution of complexity theory may predominantly lie in delineating the borders of (scientific) knowledge more precisely rather than expanding our knowledge. While Rosser (1999) admits that it is hard to point to a concrete and surprising discovery, he argues that complexity theory has changed the perspective of many economists in that what was usually seen as an anomaly may in fact be commonplace, indeed form an important aspect of the system.

This criticism of no surprising findings could also be leveled at (parts of) the perspectives presented in this thesis. After all, pointing out that the survival of the system is important does not seem to be a groundbreaking and novel insight; and similarly for the idea of enabling for-benefit institutions, encouraging the development of pro-social norms, hardening governmental budget constraints, encouraging consultation with stakeholders, the need for policy makers to be sensible, pragmatic, and to take into account common sense and multiple dimensions of a problem, redundancy as risk management, the undesirability of too-big-to-fail companies, the need to enforce skin-in-the-game, and the need to pay attention to unintended side-effects. Aren't both perspectives then (at least in part) reinventing the wheel?

A number of considerations are important here. A first consideration concerns whether one should or should not be surprised by the implications of the perspectives discussed in this thesis. Given that a considerable number of aspects (those listed above) do not seem to be groundbreaking or novel, one would presumably respond that we should not. This, however, may well be too quick. Shifting our focus to the meta-level, should we not be surprised that perspectives based on complex systems (analyzed with higher level mathematics) or wild—fat-tailed—uncertainty (where standard statistics and linear intuitions fail us) nevertheless come up with very simple and straightforward, indeed unsurprising concepts and ideas? An understandable first reaction to complex systems and fat-tailed uncertainty would be to think that one needs concepts, rules, and ideas that are very complicated and intricate in order to be able to handle such complexity or uncertainty.[39] The simplicity and perhaps even mundaneness of the actual concepts, rules, and ideas that result from the discussed perspectives should in this sense be surprising (and for some perhaps disappointing). Moreover, this simplicity is very much in line with Taleb's argument that complex systems need simple rules (which we connected to Colander and Kupers' focus on replicator dynamics), not complicated ones.

But, one may object, it is not only that the implications of both perspectives are not surprising; the implications are not very concrete either. Encouraging the development of pro-social norms is not a very concrete idea, neither is the need for policy makers to be sensible and pragmatic or the need to enforce skin-in-the-game. While this does not hold for all implications of the perspectives discussed in this thesis (it perhaps holds the least for the implications of Taleb's work, given his continuous focus on practical relevance), some recommendations are indeed somewhat vague. This, however, seems to be to some extent inherent to viewing society or the economy as a complex system. Colander and Kupers (2014), for instance, state that in the complexity frame "There can be no noncontextual general policy recommendations" (p. 182). Moreover, the vagueness of the implications fit well with the idea that public policy should be perceived as an art, an idea to which we will come back in the next chapter.

Still, is it not the case that many implications either have been discussed by earlier writers or are so common-sensical that we do not need those perspectives? To some extent, this is true. Taleb, for instance, regularly refers to previous authors (ranging from Seneca—who recognized the idea of antifragility—to Karl Marx—who realized that some things need to break in order for the system to improve—and Hayek—in particular his Nobel acceptance speech on the pretense of knowledge), and we have seen that Colander and Kupers refer to Mill's half-truth approach to policy making. Nevertheless, this does not (necessarily) mean that both perspectives are merely reinventing the wheel. For instance, given that Taleb's work is based on one idea, namely fat-tailed uncertainty with asymmetrical pay-offs (for the fragile and antifragile), one can argue that Taleb provides a unifying framework that further explains and vindicates those ideas developed by earlier writers. Similarly, the implications of the complexity frame (or of complexity economics more generally) seem to vindicate approaches that were already argued for by others—which is valuable in itself.

[39] Note that one should not equate complexity (in the scientific sense) and complicatedness (in the everyday sense).

5.2 A critical perspective on the proposed complexity frame

5.2.1 Kirman's take on complexity and public policy

The complexity perspective proposed by Colander and Kupers may seem quite radical to some. At the same time, we noted in the second chapter that the complexity economist Alan Kirman argues that Colander and Kupers are not radical enough in their view of the economy, and in particular in their assessment of the implications of complexity thinking on public policy (Kirman, 2016). The main point of contention concerns the existence of (fixed) basins of attraction and (as a result) the possibility of influencing the system in such a way that it evolves towards desirable basins of attraction.

Recall that in Colander and Kupers' complexity frame, positively influencing the evolution of the system by nudging it towards desirable basins of attraction is a main goal of public policy. In Kirman's interpretation, "The basic idea behind their account is that society or the economy will self-organize into a state that may or may not have the efficiency properties associated with an economic equilibrium. Then the problem for policymakers is to act in such a way that the self-organization does lead to a 'desirable' state" (2016, p. 536). Against this idea, he argues that a complex adaptive system such as the economy may not converge to a steady state or an equilibrium; rather, it resembles the climate in the absence of such converging tendencies. Many economists have been trying to establish a theoretical foundation for this idea of self-organization of the economy, but no satisfactory theoretical mechanism has been found so far: either it requires an unrealistically high amounts of knowledge and information-processing capabilities on behalf of individual agents, or it has no proper economic interpretation (or it makes use of Walrasian auctioneers, which can hardly be called *self*-organization). Based on this and the regularly occurring endogenous crises in economies, Kirman argues that the idea that the economy will self-organize in one state or another should be abandoned.

While Kirman correctly identifies Colander and Kupers' stand on this (see e.g. Colander and Kupers, 2014, p. 53 and p. 118), objections can be raised against Kirman's argument. One objection concerns the 'lack of theoretical foundation'-argument, for it is conceivable that there is some type of self-organization happening in complex systems that economists so far have not been able to capture theoretically. Somewhat similar to how absence of evidence is not the same as evidence of absence, the absence of a theoretical foundation cannot prove that something does not exist. In fact, given that self-organization is a phenomenon that seems predominantly (or perhaps only) exhibited by complex systems, it would be odd if models based on non-complex systems would be able to capture the phenomenon of self-organization into an equilibrium. Besides, it is conceivable that the process of self-organization is not based on prices and quantities; it could for instance be based on mostly local interactions and information transmissions.[40] Hence, the possibility of self-organization is not cut off yet—indeed, given the long history of the idea of the invisible hand, it would strike one as odd if there would be no merit at all in the idea of self-organization. Still, Kirman could counter that given the regularly occurring crises in economies, it is highly unlikely that an economy can

[40] Kirman (2016) himself refers to work done in biology that views self-organization as a dynamic process based on lower-level interactions and local information (see e.g. Camazine et al., 2001).

self-organize into a steady state. However, the occurrence of endogenous crises could be captured by the notion of *punctuated equilibrium*, a term originating in biology that describes phenomena that exhibit long periods of stasis followed by sudden changes (Gersick, 1991). Admittedly, the notion of punctuated equilibrium does not explain self-organization. However, it does show that from the occurrence of endogenous crises it does not necessarily follow that no equilibrium notion applies. Furthermore, there is a point that neither Colander and Kupers nor Kirman touch upon, namely that, arguably, the economy is not just one complex system, but consists of multiple nested complex systems—just like the system of the human body that consists of other systems such as the brain, the heart, and the nervous system. This point is also recognized by Geyer and Rihani (2010). Taking this point of view allows us to argue that self-organization may happen in various (nested) complex systems within the overall system of the economy, without needing to claim that the overall economy adequately self-organizes into a steady state.

Where does this leave us? There does not seem to be a decisive *a priori* argument for either position. Perhaps detailed case studies are the only way to find out about self-organization—or lack thereof—in particular systems, perhaps models in the complexity tradition will point towards mechanisms of self-organization and equilibrium tendencies. But how much does it matter for policy making? How dependent are Colander and Kupers' ecostructure- and norms policies on the existence of self-organization and basins of attraction? Here, an oddity can be detected. On the one hand, absence of fixed and identifiable basins of attraction seems to fundamentally undermine Colander and Kupers' proposal of positively influencing the evolution of the system by nudging it to more desirable basins of attraction (for in that case we cannot identify those, due to which we cannot nudge the system towards them). On the other hand, most examples that Colander and Kupers discuss do not seem to rely on the existence of basins of attraction, let alone fixed and identifiable ones. For instance, their most elaborately discussed ecostructure policy example—enabling and encouraging for-benefit institutions—does not seem to crucially depend on the idea of self-organization. Regardless of whether self-organizing- or equilibrium tendencies exist, opening up the possibility for organizations to explicitly adopt a goal different than that of maximizing shareholder value may well result in the development of organizations that aim to tackle certain collective (social) problems. Similarly, encouraging the evolution of (pro-social) norms by installing sidewalks (such as in the Bogota example) or in some other way does not (necessarily) require one to identify some (fixed) basin of attraction. More generally, the idea behind ecostructure policy—influencing the dynamics of the game by tweaking the rules of the game—does not seem to crucially depend on the existence of self-organization and some sort of equilibria. Though one could probably argue that in the absence of fixed and identifiable basins of attraction positively influencing the evolution of a system may be harder, there does not seem to be a principled reason why this would be impossible. Furthermore, encouraging the development of pro-social norms also does not seem to necessarily depend on self-organization and equilibria. Perhaps it is telling that in an overview of changes in how one thinks about policy making once one adopts the complexity frame, Colander and Kupers do not mention basins of attraction; the notion closest to basins of attraction in that overview is lock-in effects (see Colander and Kupers, 2014, p. 182; or appendix A). On the other hand, given that the idea of nudging the system to more desirable basins of attraction underlies a large part of Colander and Kupers' complexity frame, it would be odd if the complexity frame would be wholly unaffected by a lack of identifiable and fixed basins of attraction.

This leaves us with two unanswered questions, the first being whether (identifiable and fixed) basins of attraction exist (in the economy or in society), and the second being whether, or perhaps more accurately, to what extent Colander and Kupers' complexity frame is affected by the answer to the first question. Despite this thesis not being able to answer those questions, we may still draw some preliminary conclusions for policy makers. The first conclusion is that self-organization does not necessarily happen in the economy or in society. The second conclusion holds that a system does not necessarily tend to or rest at an equilibrium or basin of attraction. Therefore, the third conclusion is that if one wants to implement a policy based on the concepts of self-organization and basins of attraction (or some related equilibrium notion), it should first be shown that the target system indeed exhibits (or is likely to exhibit) those features (sufficiently).

A further criticism of Kirman compares Colander and Kupers to Ostrom and argues—again—that Colander and Kupers are not radical enough. Summarizing their proposed complexity frame as revolving around the decentralization of political decision-making and improving the social aspect of people's preferences, Kirman argues that Ostrom's "emphasis is on facilitating the development of institutions in which people would have a natural incentive to achieve collectively satisfactory outcomes, and not just to modify people's selfish preferences" (Kirman, 2016, p. 555). However, Kirman's representation of the position of Colander and Kupers is, I believe, uncharitable. First, though Colander and Kupers argue in favor of bottom-up processes, they do not explicitly argue for decentralization of political decision-making. In fact, they view the government as a set of institutions operating in an ecostructure space where new institutions may be developed. Given that in most developed countries a large share of political decision-making seems to be centralized, it should not come as a surprise if on balance most of Colander and Kupers' recommendations about government structure implicitly hint at more decentralized political decision-making on average. This, however, would more be the result of rather centralized political decision-making processes in contemporary developed countries than a simplistic view on the decentralization of political powers on behalf of Colander and Kupers—at least in a more charitable interpretation. The second uncharitable representation concerns 'modifying people's selfish preferences'. As Colander and Kupers repeatedly emphasize, top-down modification of people's preferences is not the way to go. Instead, they propose to encourage the bottom-up development of (prosocial) norms that are collectively deemed desirable. Recall the Bogota sidewalks example: installing sidewalks in crime-ridden neighborhoods created a natural incentive, or at least something like a natural mechanism, that encouraged the bottom-up development of social norms which in turn caused decreases in crime rates of those neighborhoods. This more charitable interpretation is in line with Kirman's characterization of Ostrom's supposedly more radical position.

Kirman also argues that the crowding-out effect—the finding that pecuniary incentives may crowd out intrinsic motivation, see e.g. Bowles (2016)—is discouraging for Colander and Kupers' proposal of encouraging pro-social behavior. A precise reading of Colander and Kupers, however, reveals that the crowding-out effect is not that discouraging. The reason for this is that a necessary condition for the crowding out effect to occur is that some pecuniary incentive is provided (for the pecuniary incentive crowds out the intrinsic motivation), and pecuniary incentives are not part of Colander and Kupers' ideas about encouraging pro-social behavior. Instead, they emphasize using findings of behavioral economics and similar fields instead of using pecuniary incentives. Their frame explicitly recognizes that people are not purely self-interested, hence policy makers operating in this frame should understand that the proposed subtle encouraging of pro-social behavior should not naively be based on pecuniary incentives and assumptions of self-interest.

Despite this partially negative assessment of Kirman's criticism, he is not mistaken about Colander and Kupers to some degree sticking to a non-complexity view of the economy and society. As Kirman (2016) notes, their widespread use of the term 'solutions' coupled with suggestions that solutions may be suboptimal strongly suggests that there are optimal solutions, a notion that does not go well together with complexity thinking. Other such hints can be found, for instance when Colander and Kupers express the hope that we "can achieve the same type of growth in social welfare that we have seen in material welfare" (Colander and Kupers, 2014, p. 276). This suggests a focus on (steering towards certain) outcomes, again something that fits the standard frame much better than the complexity frame. Related, their stating that complexity science "is nowhere near mature enough to provide sufficient guidance *yet*" (2014, p. 58; emphasis mine) seems to move away from Mill's half-truth approach to policy that, Colander and Kupers claim, their complexity frame is in line with. Besides this being in line with Kirman's criticism that Colander and Kupers are not radical enough, all this perhaps also suggests the persistence of certain ways of thinking. As a result of such persistence, adopting a complexity frame—even if one believes that is what one should do—may not be very easy or straightforward.

5.2.2 Further critical remarks

Besides Kirman's criticisms discussed above, further criticisms can be raised against Colander and Kupers' proposed complexity frame. A first critical remark concerns the likely effects of individuals adopting pro-social preferences. An implicit assumption underlying Colander and Kupers' discussion of norms policy seems to be that the adoption of more pro-social preferences (or preferences collectively deemed desirable) by individuals will lead to better or more desirable (social) outcomes on the societal level. This, however, is by no means obvious: Mandeville's *The Fable of the Bees* originally published in 1714 describes how a beehive in which vices were absent fared much less well than a beehive in which vices were more or less commonplace—an idea often taken to be behind Adam Smith's (1776) invisible hand: private vices may result in public benefits. The Czech economist Tomáš Sedláček traces the more general idea of harnessing the force of evil for good purposes (instead of getting rid of evil) to the oldest work of literature known to man: *The Epic of Gilgamesh*.[41] This suggests that evil is not something that should always be eliminated.

Furthermore, unforeseen obstacles and unintended consequences may prevent pro-sociality on the individual level from translating to pro-sociality on aggregate levels. For instance, Munk

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[41] The oldest version of the epic dates back to at least 2,000 BC. The relevant element of the epic concerns a wild and savage creature that does much damage to a human civilization but is later turned into a help for Gilgamesh (the central character of the epic).

(2014) describes how attempts of *The End of Poverty*-author Jeffrey Sachs to put his ideas about fighting poverty in practice turned out unsuccessful due to unforeseen obstacles. Regarding unintended consequences, Lentz et al (2005) recognize that food aid may create negative dependencies, that is, a reduction in the capacity of an individual or community to meet their (future) basic needs without external assistance. Add to this the ironical fact that many technologies currently in use for good purposes have been developed in the first place for military purposes (suggesting that eliminating evil on balance does not necessarily result in a positive pay-off)[42] and we must conclude that neither adopting pro-sociality nor eliminating evil on individual levels guarantees more desirable outcomes at the aggregate level.

Hence, though Colander and Kupers do not claim that we should eliminate vicious preferences, based on those considerations the general idea that by adopting more desirable (or collectively desired) preferences we will end up in a more desirable overall state does not seem to be warranted. In other words, (collectively) adopting desirable preferences does not seem to be a necessary condition for achieving desirable outcomes on the aggregate level. This does not mean that the idea of norms policy is entirely mistaken, for (some) norms may still have a positive (though non-guaranteed) influence on the evolution of the system—such as in the example of the sidewalks in Bogota—or more generally have the function of reducing uncertainty by allowing for more reliable expectations with regard to the behavior of other agents.

The idea that people can exercise self-control by deciding on collectively desirable preferences or norms via governmental institutions seems to run into a difficulty as well, namely that of heterogeneous preferences. The problem simply is that different agents may have divergent ideas about what desirable preferences or norms are, a problem that is likely to be particularly salient in times of polarization (as our current times are sometimes characterized). Hence, a majority deciding on whether some norm is desirable or not may not only be exercising a form of self-control, but also a form of control over others. The magnitude of this problem is dampened by the fact that Colander and Kupers want norms to mainly develop via bottom-up processes (thereby to some extent avoiding the 'tyranny of the majority' by allowing the coevolution of norms in distinct agents), but it seems overly optimistic to count on sufficiently homogeneous ideas on behalf of the agents regarding the desirability of certain norms and preferences.

A last critical remark concerns the belief of Colander and Kupers that "trusting in bottom-up solutions requires an optimistic view of human nature" (Colander and Kupers, 2014, p. 236). An optimistic view of human nature, however, does not seem to be necessary.[43] First, given that in the complexity frame a central question for any policy issue is whether to use a top-down or bottom-up approach, establishing that a top-down approach is very unlikely to work in some situation is a proper reason for choosing a bottom-up approach.[44] Moreover, Turchin (2007) notes that many experiments indicate the existence of several types of people in society, one division being between so-called knaves, moralists, and saints. Knaves are the

[42] Assuming for the sake of the argument that 1) eliminating evil is (conceptually and practically) possible, and that 2) military purposes are (usually) evil.

[43] Unless one understands an 'optimistic view of human nature' as the view that not all people are purely (or perhaps mostly) selfish.

[44] Although, admittedly, there is a difference between choosing for and trusting in bottom-up solutions.

egoistic people in society, the free-riders. Saints, on the other hand, are the altruists. Moralists, estimated to be the largest group, are conditional cooperators—that is, they cooperate conditional on the cooperation of others—who find joy in punishing free-riding knaves. This would probably not be deemed an 'optimistic view of human nature' by most. Nevertheless, the existence of and interaction between those different types of people seem to be stabilizing cooperation in groups: saints ensure a minimum amount of cooperation and moralists limit the free-riding attempts of knaves. This is much in line with the idea that diversity in complex systems helps to achieve systemic stability. Hence, rather than *optimism about* human nature, trusting in bottom-up solutions seems to require *diversity in* human nature.

5.3 A critical perspective on Taleb's uncertainty management

This section takes a critical look at Taleb's argument and the implications of his proposed (anti)fragility and robustness thinking discussed in the third chapter. The first subsection aims to identify what one would need to show in order to demonstrate that Taleb's argument presented here is incorrect and discusses whether this can indeed be demonstrated. Subsequently, some further critical remarks will be discussed.

5.3.1 How to show that Taleb is wrong

The argument presented in the third chapter in favor of focusing on exposure to uncertainty (by (anti)fragility and robustness thinking) is mostly based on Black Swan possibilities. Hence, one way to argue against Taleb's argument is to argue that Black Swan possibilities are very limited or (mostly) not relevant for policy makers. One way to argue this would be to show that (most of) policy making takes place in thin-tailed domains, where Black Swan possibilities are absent. In other words, one would need to show that the distribution of possible effects of most (or even all) public policies are thin-tailed. Perhaps the most convenient way to show this would be to show that there are (biological, physical, or other) limits to the effects that a certain policy (or policies in general) can generate. While it may to some extent be possible to do so, it would not so much affect Taleb's general argument presented here but rather limit the applicability of his ideas. In the end, this is an empirical matter that cannot be resolved by this thesis (though Taleb's assertion that socioeconomic life predominantly takes place in fat-tailed domains may not give one much hope that this line of argument would succeed).

Another way to argue against Taleb would involve demonstrating the continued usefulness of predictions (and perhaps conditional predictions, i.e. conditional on no Black Swan events occurring) in fat-tailed domains despite Black Swan possibilities. Demonstrating this requires showing that on balance, the damage due to not foreseeing a Black Swan event (which includes opportunity costs of missing a positive Black Swans) is offset by the gains of continuing using predictions. This again is an empirical matter, though the odds of this line of argument succeeding seem very slim given the general unpredictability in (socio)economic matters documented in this thesis, as demonstrated by various track records (see section 3.2.2). The fact that one negative Black Swan may offset a long period of small gains (and vice versa for positive Black Swans) only reduce the odds further.

Finding out a way to predict Black Swan events (or, given the definition of a Black Swan, rare events more generally) would certainly go a long way in undermining Taleb's conclusion that we should focus on exposure to uncertainty. Yet, a number of papers published in a special section of the *International Journal of Forecasting* dedicated to decision making under low levels of probability convincingly demonstrates that such rare events will never become sufficiently predictable. One reason for this is that the properties of rare events are near-impossible to retrieve from the data given that (due to their rarity) those events do not occur often in the data. There are more reasons for being skeptical about the possibility of forecasting rare events, though unfortunately they cannot be discussed comprehensively in this chapter (see e.g. Taleb, 2009b; Makridakis and Taleb, 2009; Orrell and McSharry, 2009).

5.3.2 Further critical remarks

A criticism that is regularly leveled at Taleb's ideas is that there were economists (and non-economists) who predicted the 2008 financial crisis. However, Taleb does not claim that no-one can predict an event that is a Black Swan for many people: Black Swans are subjective, an event can be a Black Swan for some but not for others. For instance, the butcher knew all along that he would kill the turkey for thanksgiving. Hence, a number of individuals having predicted the 2008 crisis hence does not mean that the crisis was not a Black Swan event for many people, it only means that the crisis was not a Black Swan *for those individuals*.

A further point of criticism is that it may not always be clear what exactly we are talking about when we talk about exposure. For instance, how could exposure to a financial crisis be delineated? Should we limit the definition of exposure in this case to people and companies directly affected, such as investment companies or bank employees, or should we take possibly indirectly affected people and organizations into account? Where to draw the line seems a hard question. At the same time, the practical purpose of Taleb's proposal dampens the need for an intellectually rigorous and detailed answer to this question; what matters is whether the answer is practically useful and effective. Though it can be argued that an intellectually rigorous and detailed answer may help in this regard, the lack of this does not seem to *a priori* undermine Taleb's position in a fundamental way (though whether it is possible to form practically effective answers is ultimately an empirical matter).

Another point of criticism concerns the completeness of Taleb's account. The distinctions between fragility, robustness, and antifragility are statistical distinctions, whereas it may be useful to know more about the (general) mechanisms that make a system (anti)fragile or robust. Though some mechanisms or factors are hinted upon (e.g. antifragility due to information), Taleb does not attempt to provide a full account of such mechanisms or factors; instead he wants to focus on statistical properties and relations. Though it may be true that Taleb's account is not complete in this sense, this is not a reason to dismiss Taleb's account; rather, it forms a reason for diving deeper in the concepts (anti)fragility and robustness that he introduced.

A last point of criticism may be that we cannot do completely without predictions. For instance, cost-benefit analyses are widely used tools for *ex ante* policy evaluations that require more or less exact estimates (i.e. predictions) of the expected costs and benefits. Besides the alternative for cost-benefit analyses in the form of measuring the (anti)fragility and robustness of (cost and benefits of) policy alternatives discussed in section 3.3.5, two further things should be noted in response. First, we do not need to do *completely* without predictions; predictions are only unreliable in fat-tailed domains. Second, given that there is no reason that the magnitude of errors in predictions in fat-tailed domains is limited, it is arguably better—when facing such fat tails—to have no cost-benefit analysis than a possibly very mistaken cost-benefit analysis (such as regularly occurring huge cost overruns, in particular in the context of big projects). Furthermore, approaches such as *scenario planning* (see e.g. Wright and Goodwin, 2009) seem to have potential for anticipating (not predicting) the future in fat-tailed domains.

5.4 Conclusion

This chapter raised and discussed some criticisms on the perspectives presented in the second and third chapter. First, it discussed what a lack of surprising, concrete, or novel implications tells us about the discussed perspectives (which is a criticism sometimes leveled at complexity theory more generally). The discussion found that this lack of surprises (which itself may be surprising), concreteness, or novelty does not mean that we should disregard the perspectives.

Subsequently, Kirman's (2016) criticisms on Colander and Kupers' (2014) complexity frame were discussed, which mostly argue that Colander and Kupers are not radical enough in their proposal because they assume that society can self-organize and that there are (fixed) basins of attraction towards which society can be nudged by policy makers. According to Kirman, those assumptions are not justified. Some further discussion suggested that whether one can assume self-organization and (fixed) basins of attraction may well depend on the situation or system at hand. Furthermore, it was noted that enhancing preferences—in particular trying to encourage pro-social preferences—does not necessarily result in desirable outcomes at the aggregate level. The idea proposed by Colander and Kupers that people can exercise self-control via governmental institutions was criticized by looking at the existence of heterogeneous preferences and norms, and their assertion that an optimistic view of human nature is required for trust in bottom-up approaches was found wanting. Despite that this discussion found a number of criticisms on Colander and Kupers' approach to be valid criticisms (or at least valid concerns), and despite Kirman's criticism, if correct, undermining the theoretical fundamentals of their frame (though seemingly not so much the practical policy examples), a charitable and more nuanced interpretation of their complexity frame still yields valuable insights and useful ways of thinking about policy making.

A critical discussion of Taleb's perspective was provided as well. Thinking about how one could prove Taleb wrong did not result in very promising ways forward. Some further criticisms, in particular on the possibility and perceived need of predicting, were found to not fundamentally undermine Taleb's proposed approach. This quite strongly suggests that there is potential in the ideas advocated by Taleb.

Chapter 6

Complexity, Uncertainty, and the Art of Public Policy

Setting aside the title of Colander and Kupers (2014),[45] the clearest indication that both perspectives fit well with viewing public policy as an art lies in how they view the relation between theory and practice. Hence, this chapter discusses how both perspectives view this relation as well as how those views relate to the art of economics as discussed in the first chapter. It also touches upon the vagueness that seems inherent in viewing economics or public policy as an art.

6.1 The relation between theory and practice: Colander and Kupers

We noted in the second chapter that according to Colander and Kupers, (complexity) theory can only provide a vision or a way of thinking about policy; it does not deliver precise answers to policy questions. Economic models and theories need to be supplemented with insights from other disciplines as well as with common sense and practical knowledge. In the end, Colander and Kupers argue, policy making should be based on what they call highly educated common sense, which involves awareness of the limitations of one's knowledge and the applications thereof but also includes knowledge of the methods and tools of the complexity frame (and other frames), accumulated experience, and of course common sense itself. The knowledge of the methods and tools of the complexity frame (and more generally being at least somewhat familiar with the dynamics of complex systems) is necessary for policy makers given that in the absence of such knowledge certain features of and tools to deal with the complex socioeconomic system may seem counterintuitive or even unintelligible. Awareness of the limits of knowledge, especially when applied to practical problems, is required given the inherent uncertainty in and uncontrollability of complex systems.

Colander and Kupers (2014) claim that viewing (socioeconomic) policy making as an art follows directly from recognizing the complexity of the socioeconomic system. At the same time, they note that an understanding or awareness of formal complexity science is not necessary for this view, given that classical economists such as Adam Smith or John Stuart Mill understood that economic policy could not only be based on economic science: it is an art.[46] This understanding was the basis for Mill's so-called half-truths approach to policy

[45] Their book is titled *Complexity and the Art of Public Policy*.

[46] There seems to be some tension between this claim that understanding complexity science is not necessary for viewing policy making as an art and the claim that policy making requires knowledge of the complexity frame. There is, however, no contradiction here, for 'viewing policy making as an art' is

making, who as noted in the second chapter utilized an approach to policy making in which intuition and general knowledge are as important as insights from formal scientific models.

Apart from this connection directed from theory to practice, there is also a connection from practice to theory: Colander and Kupers claim that "policy discussion should lead theory, not be restricted by it" (2014, p. 180). Unfortunately, they do not elaborate on what it means for policy discussions to lead theory. One possible interpretation would start at the impossibility of formulating some general economic theory, whether for practical or intellectual purposes. This impossibility in turn implies that economic theorizing (and modelling) should either aim to capture non-general aspects of a given economy (such as a particular policy issue) or aim to identify structural or systemic factors that in some way influences the dynamics of the system (such as the prevalence of trust in a society) and can hence help policy makers in making proper decisions. In other words, in this interpretation theorizing should be focused on the needs of policy makers. A second interpretation is that theorizing can be informed by the success or failure of policies. In this interpretation policies can be seen as experiments of sorts, based on which theorists can try to identify particular obstacles or catalysts in the context of a given policy or try to identify structural contributing and impeding factors for some particular policy goal. Given that the quote focuses on policy *discussions*, not policies themselves, the first interpretation is perhaps most accurate or defensible. On the other hand, the context of the quote is a discussion on whether complexity science is required to start thinking about complexity policy, to which the answer is no. This hints at the second interpretation, for in this context practice takes place first, theorizing only comes afterwards. In any case, the interpretations are not mutually exclusive; indeed, they complement each other. Moreover, either interpretation fits well with viewing public policy as an art, hence for the purposes of this thesis we do not need to establish which interpretation is the most accurate or most defensible.

6.2 The relation between theory and practice: Taleb

Taleb's view of the relation between theory and practice is a bit more radical than that of Colander and Kupers. He approvingly refers to the economist Ariel Rubinstein, who refuses to claim that he can translate his theoretical knowledge to something practically useful (Taleb, 2012; see also Rubinstein, 2006). According to Taleb, Rubinstein sees economic theories as similar to fables—they may play a role in stimulating ideas and indirectly inspiring practice, but they cannot direct or determine practice. Taleb agrees: "Theory should stay independent from practice and vice versa—and we should not extract academic economists from their campuses and put them in positions of decision making" (Taleb, 2012, p. 211-12).

This position of Taleb can be related to his focus on exposure to uncertainty, instead of on uncertainty itself. Roughly, the argument is the following: academic economists focus on understanding (causes and consequences of) events, (causal) relations between events, and perhaps other characteristics of those events. Such understanding, however, is not (always)

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not the same as 'making proper policy'. Knowledge of complexity science is not necessary for the former, though it is at least helpful for the latter.

relevant for practice, because in practice one should care about the payoff distribution, i.e. about the exposure to possible consequences of an event, and the payoff distribution of an event may have very different properties from the event itself. An example of Taleb illustrates this: in the run up to the Kuwait war, many investors had studied the Kuwait region, the tensions in that region, and the attitudes of the U.S. government and the NATO towards the situation, based on which they were betting on the oil price to go up due to expected decreases in oil supplies in the case of war. However, on the day that the U.S. attacked Baghdad (January 16th, 1991), oil prices went down instead of up, and drastically so, thereby bankrupting a non-small number of investors. This example shows that understanding the situation in Kuwait and Iraq was of not much help for making proper investment decisions, as the price of oil did not respond in the way expected based on careful study. Indeed, the oil price simply follows the market dynamics of demand and supply, which may be independent of putative fundamental factors that supposedly determine the price of oil (or so Taleb argues). Another example that Taleb refers to can be found in the intellectual memoirs of Ariel Rubinstein (2012), in which Rubinstein recounts how he tried to apply a bargaining model based on game theory to a bargaining situation in a traditional market in which traditional bargaining methods were used. The attempt failed to yield an acceptable price for both parties, leading the vendor to remark that "For generations, we have bargained in our way and you come and try to change it?" (Rubinstein, 2012, p. 34). Understanding the dynamics of (rational) bargaining hence is not (necessarily) of much help in practice.

Given that Taleb does not explicitly spend many words (besides the above quote) on the relation between practice and theory but approvingly refers to Rubinstein, we may get a better idea of Taleb's likely position by having a look at Rubinstein (2012). Rubinstein denies that economic models can be directly practically useful and argues instead that economics studies 'the logic of life', thereby dealing with a "wide range of considerations that economic decision makers might take into account" (Rubinstein, 2012, p. 36). Theorizing and abstract understanding is therefore at most indirectly useful in practice; it entails studying and theorizing about considerations or phenomena that decision makers *might* want to take into account.

This fits well with some views and arguments expressed by Taleb. For instance, Taleb (2010) views complexity theory as yielding some useful insights about socioeconomic phenomena—as long as one does not use complexity theory to get precise models of reality or answers to practical problems. Furthermore, we noted that when discussing Ricardian comparative advantage Taleb (2012) claims that though the insight that specialization is beneficial is a valid one, a top-down implementation of such specialization will lead to failures. Instead, specialization is to be achieved via bottom-up evolutionary processes, for "systems make small errors, design makes large ones" (Taleb, 2012, p. 450). This is an example of a theoretical insight of an economist that can inspire practice, though it cannot directly be applied to practice.[47] Besides emphasizing the limited usefulness of (precise) scientific models and theories, Taleb mainly advocates simple practical reasoning as an antidote for the complexity of the system, in particular by emphasizing his ideas about uncertainty management and generally advocating the use of practical heuristics (as long as one keeps in

[47] In the sense of top-down implementations.

mind that heuristics are not perfect rules). Given this, Taleb's view of the relation between theory and practice is largely compatible with the view of Colander and Kupers discussed above; the views mostly differ in that Colander and Kupers seem (much) more optimistic about the usefulness of scientific theories and models for policy making.

Besides claiming that practice should be independent of theory, Taleb also claims in the above quote that theory should be independent of practice. This seems to go against the view of Colander and Kupers that practice should lead theory. Unfortunately, Taleb does not elaborate on his reasons for this, hence this thesis will not discuss this further.

6.3 The vagueness of art

The previous chapter discussed the criticism that the concepts and ideas advocated by the perspectives discussed in this thesis are not truly surprising and (at least some) are indeed rather vague. We noted that this criticism of the results being vague may in fact align well with the idea that public policy should be perceived as an art. The reason for this is that, as noted in the first chapter, the methodology of the art of economics (and hence of the art of public policy, see section 6.4.2) is not formal and not very exact. This, combined with Colander's (2001) argument that the exactness of an answer depends on the least exact input for that answer, at least suggests that the vagueness of the implications of the discussed perspectives is not problematic for public policy perceived as an art. Moreover, given that public policy perceived as an art entails being sensitive to various real-world dimensions and practical issues, the vagueness of (some of) the concepts may in fact leave necessary room for interpretation and modification, according to the requirements of the situation or problem at hand. Accepting this argument means that the vagueness of (some of) the concepts and ideas should not be seen as a drawback, but as something desirable given that it leaves sufficient 'wiggle room' for policy makers to adapt or interpret the concepts and ideas according to their needs.

In this context, it is interesting to spend some more words on the idea of scenario planning, an idea that as noted in the previous chapter seems well suited for anticipating fat-tailed uncertainty (see e.g. Wright and Goodwin, 2009). Scenario planning can help decision makers to understand possible consequences of their actions depending on the scenarios that play out in the face of uncontrollable, unreducible uncertainty. Literature on scenario planning has applied the idea to conservation policies (Peterson, Cumming, and Carpenter, 2003), public policy more generally (Volkery and Ribeiro, 2009), and other topics. It is a method designed for systematically thinking about the uncertain future, or in fact about multiple possible futures, whereby it inter alia relies on a wide range of informational sources, discussions within diverse groups of people, intuitive logic, and creative reasoning. Early adopters of scenario planning methods, such as Royal Dutch Shell, have outperformed their competitors in certain respects based on their use of scenario planning (Schoemaker, 1995), which suggests that it may be a useful tool for policy makers as well. If this is true, then this once more demonstrates that precision is not a desideratum when making decisions in the face of (fat-tailed) uncertainty, for scenario planning relies on creativity and intuition much more than on calculation and formalization. Given that it seems defensible to claim that scenario planning is closer to art than to a science (a claim supported by its practitioners, see Volkery and Ribeiro (2009) p. 1205-1206), it follows that precision is also not a desideratum for an art—which is clearly in line with the argument above.

6.4 Theoretical science and practical art

6.4.1 The art of economics and the relation between theory and practice

In the first chapter we noted that the purpose of the art of economics is to solve real-world problems. Its methodology is (usually) not formal, not very exact, and largely non-economic in character. It may be inspired by formal economic theories, but also by other disciplines, practical reasoning, and educated common sense as various dimensions important in the real world need to be taken into account. How does this fit the views on the relation between theory and practice just discussed?

The focus of Colander and Kupers is indeed on solving real-world problems—or, perhaps more accurately, mostly on enabling people to solve real-world problems. The methodology they endorse uses input from multiple sources—economic as well as non-economic, formal as well as non-formal, theoretical as well as practical, formal as well as intuitive. This wide range of sources, both in terms of substance and form, implies that the methods used will be largely non-formal, non-exact, and non-economic in character. Therefore, Colander and Kupers' view of the relation between theory and practice fits well the art of economics.

Taleb's focus is on solving real-world problems as well—in particular on preventing big problems from arising. His methodological emphasis is mostly on what *not* to do: do not try to get precise answers, do not try to achieve certainty (especially about causal relations), and do not naively apply theoretical insights to practice. Regarding what we should do, this mostly revolves around practical reasoning, using simple heuristics, and being aware of the limitations of the methods and tools that are used. This fits well with the lack of formality, exactness, and economic character that characterizes the art of economics.

Furthermore, both perspectives clearly do not fit well with viewing public policy as a pure science, given that both perspectives ask much more from policy makers than applying formal economic theories to policy problems—indeed not only much more, they also ask for a very different way of thinking.

6.4.2 The art of economics and the art of public policy

Having established that both perspectives are in line with economics perceived as an art, one question remains: what, if any, is the difference between the art of economics and the art of public policy, and does this have implications for what has been established so far in this chapter? Unfortunately, Colander and Kupers (2014), though explicitly referring in their title to 'the art of public policy', do not provide a definition of this art of public policy. Nevertheless, providing a rough but plausible definition is quite straightforward: it is simply the art of economics focused on public policy questions and problems. In other words, the art of public policy is a subset of the art of economics. If one accepts this definition, then it follows that any perspective that is in line with the art of economics is also in line with the art of public policy. Given this, it follows that both perspectives discussed in this thesis indeed exemplify how public policy as an art can or should be approached.

A last thought on the art of economics and the art of public policy is that one may wonder what other real-world problems than public policy issues may be out there, given that the art of economics is broader than the art of public policy. The answer is that this may range from personal economic issues to economic questions at the company level, in other words, anything that involves (some) economics and forms a practical problem or issue. Regarding this, it is perhaps worthwhile to note that Taleb's work seems to fit the more general art of economics, whereas Colander and Kupers' work is mostly limited to or mostly focusses on the more narrow art of public policy.

6.5 Conclusion

This chapter discussed how both Taleb and Colander and Kupers perceive the relation between theory and practice. Both Taleb and Colander and Kupers want to separate practice and theory, though compared to Colander and Kupers, Taleb seems more radical in this separation in that he sees less room for theory when addressing practical issues. The chapter also touched upon the seemingly inherent vagueness of 'doing art'. Based on those discussions, the chapter argued that both the perspective of Taleb and that of Colander and Kupers fit well with perceiving public policy as an art.

Chapter 7

Conclusion and Afterthoughts

The curious task of economics is to demonstrate to men how little they really know about what they imagine they can design.
—F.A. Hayek

7.1 Wrap-up

This thesis attempted to achieve a twofold goal: one the one hand, it aimed to connect the work of Nassim Taleb to complexity economics (in particular in the context of public policy), and on the other hand it aimed to present two perspectives on public policy and discuss how they exemplified the idea of viewing public policy as an art. The first perspective, based on Colander and Kupers' (2014) *Complexity and the Art of Public Policy*, looks at public policy from a complexity theory perspective, whereas the second perspective, based on the work of Nassim Taleb (in particular Taleb, 2012, 2014), looks at public policy from an uncertainty management perspective.

Colander and Kupers (2014) present the so-called complexity frame, which is supposed to partially replace the so-called standard frame. The standard frame corresponds roughly to how mainstream economics would view public policy, in which two positions can be distinguished: either leave social problems to be solved by the market, or engage in active government interventionism. Against this, Colander and Kupers argue that research in the complexity tradition (on which their complexity frame is largely based) suggests that such an opposition between market and government is artificial; rather, both government and market are necessary, for the government has to facilitate the workings of the market. The role of public policy in the complexity frame is twofold, namely ensuring the survival of the economic or societal system and positively influencing the evolution of institutions in that system. Generally, public policy in the complexity frame tries to enable and encourage bottom-up approaches to solving societal problems instead of engaging in top-down government interventions. This focus on bottom-up approaches instead of top-down interventions is argued for by referring to the uncontrollability of and uncertainty inherent in complex evolving systems, of which, Colander and Kupers argue, our societies and economies are instances.

The work of Nassim Taleb can be characterized as revolving around a focus on exposure to uncertainty, that is, how much an entity or system can be harmed by or gain from uncertainty (or randomness or disorder). This focus on exposure to uncertainty is supposed to replace the focus on uncertainty itself. In other words, instead of trying to reduce uncertainty via predictions, the idea is to prepare for uncertainty. The argument against prediction is mostly based on the occurrence of Black Swan events, which are unexpected (very) high-impact events. Those Black Swans occur only in fat-tailed domains (as opposed to thin-tailed domains), hence the focus on exposure to uncertainty is most relevant in fat-tailed domains. Focusing on exposure to uncertainty can be done by thinking in terms of (anti)fragility and robustness, which indicates positive and negative exposure to (fat-tailed) uncertainty.

After presenting both perspectives, this thesis continued with connecting both perspectives in an attempt to achieve the first goal of connecting Taleb's work to the complexity tradition. Both similarities and differences were identified, where differences were mostly (though not only) found to be complementary.

Having done this, the thesis turned to a critical discussion of both perspectives. The critical discussion of the complexity frame is partially based on a review essay of Kirman (2016), whose position seems a bit more radical than that of Colander and Kupers. Though some valid criticisms and concerns about the complexity frame were identified, a charitable and nuanced interpretation of their frame still yields useful insights and ways of thinking about public policy. Regarding Taleb's work, assessing how one could prove his argument wrong suggested that this would not be easy, though in the end it is an empirical matter. Other criticisms were raised but turned out to pose no threat for Taleb's approach.

The sixth (and last substantial) chapter, finally, discussed how both Taleb and Colander and Kupers perceive the relation between theory and practice, and linked this to the overarching aim of this thesis, being to show that both the complexity and the uncertainty management perspective can serve as examples of how public policy as an art can be instantiated. Both perspectives advocate a separation of theory and practice, based on which it was concluded that both perspectives indeed exemplify public policy perceived as an art.

7.2 Afterthoughts

This section marks the end of this thesis, which I will use to convey two afterthoughts. The first one concerns a threat of misinterpretation, the second one concerns a thought on how one could perhaps best perceive the relation between the perspectives discussed in this thesis in the practical context of policy making.

The threat of misinterpretation is the following. Given the emphasis of both perspectives (though in particular of Colander and Kupers) on the use of a wide range of sources that may be non-formal, non-exact, and non-economic, one may fear that perceiving public policy as an art does not mean much more than adopting an *anything goes* attitude. This, however, would be mistaken. Though the perspectives discussed in this thesis may lack academic rigor, they do advocate practical rigor (which is in particular emphasized by Taleb throughout his *Incerto*). That is, the value of approaches and tools in those perspectives are assessed based on practical usefulness, adequacy, and reliability. Academic rigor is thus replaced by practical rigor, which should not be surprising given that this thesis has argued that public policy should be perceived as an art, which focuses on doing and real-world problem solving, instead of as a science, which focuses (or should focus) on matters abstract and intellectual. Practical rigor is suitable for the art of public policy, academic rigor is suitable for positive economics.

Then, the relation between the perspectives discussed in this thesis in the context of policy making. Both perspectives have a different focus and a different basis. The basis for Colander and Kupers' perspective is complexity theory, whereas the basis for Taleb's perspective is statistical risk (or uncertainty-) management. A considerable part of Taleb's work is devoted to how to prevent or at least mitigate the effects of negative Black Swan events, and more generally how to cope with negative exposure to fat-tailed uncertainty. This preventing or mitigating the effects of negative Black Swan events—and more generally preventing or mitigating negative exposure to uncertainty—may form a solid fundament of sorts for policy makers: as long as negative exposure to fat-tailed uncertainty (including Black Swan events) is limited or otherwise properly dealt with, one can engage in other things (say enabling new organizational or institutional structures adequate for bottom-up approaches towards solving collective problems, seeking positive Black Swan exposure, or Kirman-style careful observation of the economy in order to find possibilities for influencing the system) without worrying about rare high-impact events. Hence, though the complexity frame of Colander and Kupers is presented first in this thesis, the work of Taleb may in fact best serve as the overall foundation for policy making (in fat-tailed domains), supplemented by the perspective offered by Colander and Kupers and a perhaps more fully worked out perspective of Kirman (or that would be my conjecture).

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Appendices

Appendix A: An overview of changes resulting from adopting the complexity frame in the way we think about economic policy (Colander and Kupers, 2014, p. 182)

1. We don't understand the complex evolving economy, and probably can never understand it fully. Complex systems are not amenable to control, and we should give up the ambition to control the economic system.
2. While we cannot control the system, we can influence it in a myriad of ways; the standard policy model rules out many of these avenues; influence comes about not just through incentives within the existing institutional structure. A key focus of policy within the complexity policy frame involves positively influencing the evolution of institutions.
3. The economy and the government are coevolving complex systems that cannot be considered separately. There aren't separate market and government solutions to problems. Solutions can be more bottom up or more top down, but both require some type of either explicit or implicit government policy to bring about, even if that policy is to do nothing. The market is not the opposite of the government; successful market economies are testimonies of the success of previous government policies.
4. The success of bottom-up policy depends on the ecostructure within which people operate and the normative codes that they follow. Thus ecostructure and norms policy are central to complexity policy.
5. There is no general complexity policy; complexity policy is contextual, and consists of a set of tools, not a set of rules, that helps the policy maker to come to reasonable conclusions.
6. Government is an evolving institution, and can evolve in different ways. Complexity policy includes policies that affect government, and the role of government will change with the problems and the current state of government. There can be no noncontextual general policy recommendations.
7. Complex systems often experience path dependencies, nonlinearities, and lock-ins. Methods need to be designed to determine when these have occurred, and policies reflecting these dynamics need to be designed to influence the economy's evolution.
8. Policies can be achieved with bottom-up or top-down methods of influence. A top-down policy should not be seen as a one-time policy, but as a policy process that evolves as institutions evolve. Bottom-up policies allow endogenous evolution as institutions involve.

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