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Theme issue contribution

On Green Swans and Catastrophic Futures: Climate change as risk and uncertainty in central banking

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Abstract
This article analyses how central banks understand the financial risks thought to arise from climate change as uncertainty within complex systems rather than risk as something statistically measurable. In line with pragmatic sociology, I investigate what this uncertainty enables, instead of taking it to be an epistemological limit to knowledge. Analysing a 2020 publication by the Bank for International Settlements and Banque de France called 'The green swan', I show how 'climate risk' is framed as a 'black swan', a conceptualization taken from the field of complexity theory, meaning unlikely, extreme events that cannot be predicted, implying a critique of economic expertise. In the figure of the green swan, however, the statistically improbable climate crisis is additionally framed as a certainty. I argue that 'the green swan' through this tension works to include critique and value financial climate risk as a 'good' in order to provoke a precautionary response on this risk instead of proposing more explicit political measures on climate change. This demonstrates that while uncertainty challenges economic expertise, it also enables the linking together of the 'good' of the climate and the 'good' of the financial system, bringing them together in the politics of climate change.

Keywords: climate risk; green central banking; document analysis; finance; uncertainty; critique

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Introduction

To the financial mind, a recent consensus has emerged that the future is not only catastrophic but that we are living on the very brink of several crises, happening all at once and intersecting in complex ways.[1] This entails acknowledging the acuteness of the so-called European energy crisis, the war in Ukraine, the Covid-19 pandemic, and most detrimental of all, the climate crisis. It also means that these so-called crises should be understood as threats towards creating a *financial* crisis. Climate change especially is increasingly taken to be such a threat to the financial system, and accordingly, many central banks have started to include climate change in their operations as a specific form of financial risk in order to avoid a climate-induced financial crisis.

Central banks' work on climate change should be understood, more generally, as part of an increasing intermingling of financial and climate concerns (Bridge et al. 2020; Chiapello 2020). To understand this intermingling, the notion of 'climate risk' is important as it is one of the key concepts around which finance organizes its work on climate change (Christophers 2017, 2019; Täger 2022; Engen and Asdal 2024). Central banks have also been called on to act on climate change, and it has been noted how 'green central banking' holds promises to fill the green transition's identified 'investment gap' in the form of a 'Green Keynesianism' or 'Green New Deal' (Langley and Morris 2020). It is, however, not immediately obvious how climate change has come to be an issue for central banks, and it is a development that must be viewed together with a broader change in financial regulation that has been taking place since the 2008 financial crisis – an event which spurred a new form of crisis management in central banking (Langley 2015). Although a fundamental societal role of central banks is the management of currency within some country or monetary union, central banks have in recent years taken on a role as a form of ultimate lender in times of crisis, through which they have arguably also gained greater importance and structural power (Harvey 2011; Bowman et al. 2013).

Tied to this change in roles, the framing of climate change as a form of financial risk that can be managed by central banks also follows a changed understanding of the notion of risk itself. For example, after the financial crisis, the Bank of England went through a problematization and questioning of what exactly constituted financial risk, leading to a broadening of the term, so that the bank started to include not only climate change but also cyber security and Brexit into their risk analysis (Morris 2018). Writing immediately after the 2008 crisis, Tellmann (2009: 17) noted how 'the catastrophic nature of the

[1] For example, the 'Global risks report 2023' by the World Economic Forum was introduced in an accompanying article with the headline: 'We're on the brink of a "polycrisis" – how worried should we be?' (Torkington 2023).

financial crisis' was perceived by the Basel Committee on Banking Supervision as a result of lacking risk estimation, not as faulty calculations, but as a 'failure of imagination' about what the future held in store (Basel Committee on Banking Supervision 2009: 17, cited in Tellmann 2009). The financial future was now 'uncertain', 'complex', and 'unknown', made up of 'fractals', 'fat tails', and 'tipping points' (Tellmann 2016). Catastrophe was hence expected, Tellmann (2016: 75) writes, as 'the future is not an indeterminacy to be seized, but an incalculable event with potentially catastrophic bearings which are to be anticipated and prepared for'. To deal with such catastrophic uncertainty, Cooper (2011: 373) has noted how discussions on regulatory reform after the financial crisis included calls to integrate 'complex systems theory', which is 'interested in how systems adapt, evolve and self-organize not in spite of crisis but *through the very means of crisis*'. In this way, according to Cooper, central banks found a way to pre-empt crisis, even when it was established that it could not be predicted through calculative devices. Contrary, then, to what economists like Friedrich Hayek predicted, complex systems theory has led not to the demise of the centralized economic governance of central banks, but rather to a change in their institutional authority, fuelled by the threat of crisis (Cooper 2011).

This article follows these identifications of a shift to uncertainty and complexity theory within central banking and shows how the theorizing of risk as uncertainty within complex systems is now being used by central banks to understand and work on climate change. More concretely, I analyse a 2020 publication by the Bank for International Settlements (BIS) and Banque de France called 'The green swan: Central banking and financial stability in the age of climate change' (Bolton et al. 2020).[2] I show how the risks thought to arise from climate change are framed as 'black swan events', a conceptualization taken from the field of complexity theory, meaning unlikely yet extreme events that cannot be predicted. The black swan theory, in this way, implies an explicit critique of the economic knowledge and expertise of central banks. I show how, through a twist of uncertainty, 'the green swan' turns this critique from a critique of expertise to a critique of modelling, where expertise is in fact crucial to reframing the issue to make it knowable and so pre-empt the crisis. As I argue, 'the green swan' thus separates the authority of central banks' expertise from the models they make use of. In making this argument, I follow Tellmann (2016) in taking uncertainty not as indicative of an epistemological limit to knowledge, but rather as a pragmatic 'tool of critique' that enables 'shifting epistemologies and changing regimes of governing the future'. I further show how, to manage uncertainty, 'the

[2] Since the document itself plays a significant role in the analysis, it will be referred to not by the standard 'author, date', but as 'The green swan'. The full reference can be found in the reference list as Bolton et al. (2020).

green swan' turns the statistically improbable climate crisis into a catastrophic certainty. I argue that the tension that arises between uncertainty and certainty is indicative of a dilemma central banks face in wanting to incorporate the critique of modelling while not wanting to step out of an 'expert', 'non-political' role. As an alternative to this, I argue that 'The green swan' document works as a 'tool of valuation' (Asdal 2015) that aims to make financial climate risk into a 'good', and value it as such a 'good' so that such risks are taken into consideration by both financial and political actors, thus relieving central banks of having to take explicit climate action. I propose to understand this move as a governing of climate change in the form of a 'good economy' (Asdal et al. 2023), first turning climate change into financial risk and then managing this risk by valuing it as a 'good'. Importantly, this 'good' is at once composed of the stability of the climate system and the financial system. As this demonstrates, even if uncertainty complicates economic expertise, it may also be used to tie together different issues and the normativity that comes with them, making financial climate risk into a 'good' to be dealt with in the politics of climate change.

While Banque de France, one of the two institutions behind 'The green swan', is perhaps familiar to many as the central bank of France, the Bank for International Settlements (BIS) remains a more obscure institution. The activity most closely associated with the BIS is the Basel Committee on Banking Supervision, which is the primary global standard setter for banking regulations, creating so-called 'soft law'. This 'Basel system' saw the light of day in 1974, when, after the tightly regulated Bretton Woods system had been dismantled, the new stream of global and deregulated finance was seen to cause instability in financial markets and ultimately banking crises (Borio et al. 2020). In more common terms, the BIS is often called 'the bank of central banks' (Hayes 2022) and even 'the secret bank that runs the world' (LeBor 2013). A more sobering understanding of the BIS is laid out by Westermeier (2018: 171), who proposes to think of it as 'an influential think tank within the community of financial policy-makers', and so an important part of 'the epistemic community of central bankers'. This view echoes how the BIS presents itself: on the question of whether it is a 'research institution', their in-house podcast 'BISness' established that 'it is, and it always has been' (BIS 2020). This is how I will think of them here.

Following from this, I analyse 'The green swan' as a product of these two institutions but also, more broadly, as tied to a larger network of central banks and the ongoing knowledge creation on the interlinkages of climate change and the financial system. In this article, I focus on how the issue is presented and modified in the document and not on the document's audience or how it has circulated and been put to work more concretely after being published. More specifically, I

analyse 'The green swan' following a practice-oriented method of studying documents (Asdal and Reinertsen 2021), drawing on lessons from material semiotics, which highlights how documents are not simply text, but should be analysed as material tools that take part in shaping the issues they present. To give some indication of its reach as a knowledge object, however, it should be noted that 'The green swan' has amassed more than 700 citations on Google Scholar in the five years since it was published.

The article proceeds as follows. The first section delineates the different streams of literature my analysis builds on. A primary literature deals with how central banks since the 2008 financial crisis have begun working with a notion of risk oriented towards uncertainty, trying to foreshadow crisis. A second literature offers a theoretical framing by pointing to how risk and uncertainty can be taken to be performative notions that create and frame issues, rather than simply describe them. Finally, an additional literature, on which the article is methodologically based, is oriented towards the use of studying documents to investigate these questions. The next three sections move into the document, unpacking the theoretical underpinnings of the green swan figure, showing how uncertainty as critique is used actively to modify the issue. Through these three sections, I analyse three different forms of uncertainty which are mobilized in the figure of the green swan: uncertainty as a black swan, uncertainty as an epistemological obstacle, and uncertainty as the certainty of crisis. In this last section, I also analyse what form of 'good economy' can be said to emerge and reflect on what this means for 'green central banking'.

Uncertainty and risk after the financial crisis

It is broadly recognized that the 2008 financial crisis marked a shift in the understanding of risk within central banking. The Bank of England, for example, started focusing on analysing a future thought to be different from the past and 'a concern for extreme or possible financial events, rather than normal or probable ones' (Morris 2018: 1). Studying one response to the crisis, the US Treasury's Supervisory Capital Assessment Program (SCAP), Langley (2013) has noted how this so-called 'stress-test' marked 'a very public turn to anticipatory techniques designed to ensure preparedness for low-probability, high-impact events'. It was a rejection of more traditional, calculative, and statistically based risk modelling, which was now put under critique, as it was not just the future-oriented aspect of stress-tests and scenarios that made them attractive as modelling alternatives, but also that they were thought to be 'non-statistical' (Langley 2013: 12). These new models were, however, no less concerned with seeking truth and leaving the uncertain future open. In fact, the European Central Bank

used stress-testing as a 'truth operation' to assess if banks could withstand the 'stress' of a financial crisis (Violle 2017). In this sense, it has been said that the government and regulation of the 2008 financial crisis provided 'a significant spur to the development of techniques that govern through, as opposed to against, uncertainty' (Langley 2015: 11).

This shift to governing *through* uncertainty has, however, not been viewed as wholly unproblematic. Many economists have, for example, noted how this new focus on 'uncertainty' and 'future-oriented systemic risk' has led central banks into new territory, both in terms of underdeveloped economic science (Goodhart 2015; Thiemann 2019) and in terms of their expert status (Thiemann et al. 2021: 1434). The political scientist Jacqueline Best (2022: 2) has called such situations 'uncomfortable knowledge' because 'central banks' authority is linked to their expertise, the knowledge that is often most uncomfortable for them is the fact of their own ignorance in the face of an uncertain economy'. In this take on things, uncertainty becomes a category representing a limit to knowledge, which hinders the economist from successfully using traditional calculative methods (Bronk 2009; Beckert 2016; Beckert and Bronk 2018).

If uncertainty represents such a limit to expertise, what are we to make of the fact that it is introduced as a critique from within the ranks of central banks themselves? Bear (2020: 2) has recently noted this critical tendency, specifically within central banks that 'question formal equilibrium models and explore the human foundations of economic action'. It is a critical trait that, according to Bear, is recognizable in that it has been internalized in the very practices and institutions that are the subject of critique. The analysis echoes the argument, famously made by Boltanski and Chiapello (2018), that *capitalism*, which they understand to be 'capital accumulation', gains its legitimacy by transforming itself in accordance with the criticisms it is faced with. This has the perhaps discouraging consequence that the same ideas that offer a substantial critique of economic order can also be used to legitimize and uphold it (Boltanski and Chiapello 2018: 20). To examine how such criticisms function, Bear (2020: 2) suggests analysing them as 'technologies', where such technologies can be anything from, for example, promotional brochures, international agency reports, or risk analyses, which are 'deployed to anticipate the future; to stimulate its emergence; and to control it' (Bear 2020: 8).

The question then becomes what this turn to uncertainty entails and enables, shifting the focus away from what it proposedly limits. In this way, following Tellmann and more broadly the pragmatic approach, 'uncertainty and unknowability is but a name for a reorganization of knowledge production' (Tellmann 2016: 67). Doganova (2024) has made a similar shift in her analysis of how the staging of the financial future as 'uncertain' has worked to devalue the future through

discounting it, the most detrimental consequence of which is the political inaction on climate change. Similarly, in his studies on risk, Power (2016) has underlined how risk is not something out there, but rather that 'riskwork' is the work occupied with the making of things into risk, and linked to this, legitimizing who should manage it. This indicates that risk management is highly performative in that 'the ability to package it and make it visible and institutionally acceptable must be understood as an outcome of varied forms of riskwork rather than a starting point or presumption' (Power 2016: 8).

There are clear parallels between Tellmann, Doganova, and Power's understandings of how the management of 'uncertainty' and 'risk' is performative. Importantly, this entails that the stark separation between these two terms, often held up in economic theory and attributed to the economist Frank Knight, is a misleading route to follow in understanding how riskwork functions, since this separation is arguably part of the very riskwork itself. Moreover, it points out how framing risk as uncertainty does not have to be uncomfortable for central banks but can be used actively and strategically to organize governance on certain issues. The central banks' work on turning climate change into a certain form of uncertainty or risk – for example 'a green swan' – can in this way be seen as such performative riskwork, where the shaping of the issue as a specific risk issue both brings the figure of the green swan into being and negotiates who should work on and manage this risk.

In line with other work (Engen and Asdal 2024), this article investigates the ongoing shaping of climate change as a certain type of risk, treated as an empirical object, 'asking when and how uncertainty [or risk] is mobilized and by whom, what forms it takes, and what effects it produces' (Doganova 2024: 170). This pragmatist take consequently also means paying attention to the ambivalences and 'mess', as John Law (2004) would put it, that appear in the effort to theorize climate risk. As I will show, such mess is quite present in the figure of the green swan. Investigating how uncertainty works as a 'tool of critique' (Tellmann 2016) is hence oriented towards paying attention to how negotiating uncertainty is a way of organization, or alternatively, how economics is not mainly a theoretical endeavour but a means of administration (Langley 2015: 9).

In this article, I study central banks' work on climate change through publicly available, published documents. Others have more generally noted the importance of looking at written material produced by central banks and understanding these documents as part of their governing strategy. For example, Hall (2008) has suggested that the governance mechanisms of central banking, which are based on the task of creating, valuing, and destroying money, are more social than mechanical, and make use of 'discursive practices.' Holmes (2013) has similarly argued that the communications of central banks work

performatively and subsequently create an 'economy of words.' By studying the document analysed in this article in a practice-oriented way (Asdal 2015; Asdal and Reinertsen 2021), the aim is to tie this discursive layer to a material semiotic insight into how documents may also work as tools for reorganizing knowledge production on climate change. More generally, practice-oriented document analysis springs from the turn to practice in the social sciences, and specifically actor-network theory, material-semiotics, and Foucauldian governmentality studies, where the proposed separation between what is called 'the discursive' and 'the world outside of the text' is renegotiated (Asdal and Reinertsen 2021). In that sense, 'documents are tools through which the world is modified and transformed, and these specific and ongoing modifications are made into our objects of study' (Asdal and Reinertsen 2021: 217). Following this take on documents, I use the notion of 'tool' in the material-semiotic sense, referring to the green swan as both the semiotic figure that is set up and the document of the same name. It is in this sense that I take 'The green swan' to be a 'tool of critique' and a 'tool of valuation', meaning a material-semiotic tool which facilitates the reorganization of knowledge production around climate risk within 'green central banking', and the financial sector more broadly.

Uncertainty as a black swan

The BIS websites are sober, mainly clad in dark red and grey. By following a drop-down menu to 'research and publications,' among a vast number of publications on central banking and the global financial system, one finds 'The green swan'. Indeed, when opening the file, a swan with bright green feathers is swimming on the front page of the document, its head slightly bowed down.

Figure 1: The front page of 'The green swan'.
Source: The green swan (2020).

As I have already briefly mentioned, the green swan is a twist of the 'black swan,' a highly influential concept developed by risk analyst and financial trader Nassim Nicholas Taleb (2007). Taleb's black swans are part of a theorizing of risk that is oftentimes grouped together in a field called complexity theory, which aims to understand the complexity of systems. In Taleb's use, black swans are events that are highly unlikely and unpredictable, but which should nonetheless cause concern, as they will have extreme consequences if they do occur. That such unpredictable events exist at all poses a great problem to those who aim to know the future, be it for reasons of financial speculation or otherwise. The knowledge problem the existence of black swans leads to is, in this sense, a classical one, echoing David Hume's problem of induction: how can we know that what has happened so far is indicative of what will continue to happen? Or as Taleb begins his book, 'Before the discovery of Australia, people in the Old World were convinced that all swans were white, an unassailable belief as it seemed completely confirmed by empirical evidence' (Taleb 2007: xvii). The discovery of black swans – which do exist in nature – broke the former belief that all swans were white. To Taleb (2007: xvii), the existence of black swans

> illustrates a severe limitation to our learning from observations or experience and the fragility of our knowledge. One single observation can invalidate a general statement derived from millennia of confirmatory sightings of millions of white swans. All you need is one single (and, I am told, quite ugly) black bird. (Taleb 2007: xvii).

As a financial trader, Taleb (2007: xxvii) uses the figure of the black swan to point to what he calls 'the structure of randomness in empirical reality', which to him indicates that calculative efforts to measure risk are futile and that 'the reason free markets work is because they allow people to be lucky, thanks to aggressive trial and error, not by giving rewards or "incentives" for skill' (Taleb 2007: xxi). In this way, Taleb's black swan not only serves to repeat Hume's inductive problem but also puts forth a harsh criticism of economic experts, which Taleb scorns throughout the book as 'empty suits' (Taleb 2007: xx) that are 'phenomenally skilled at self-deception by burying the possibility of a large, devastating loss under the rug' (Taleb 2007: 43). A list of 'experts who tend to be … not experts' even explicitly mentions 'Bank for International Settlements staff' (Taleb 2007: 146–147), making the fact that the BIS has brought Taleb's black swan into its own work somewhat surprising. By making use of the notion of the black swan, which so explicitly challenges central bank expertise, the green swan document hence makes its first move as a tool of critique, internalizing the critique of expertise that this uncertainty brings with it.

'The green swan' document presents 'black swans', in line with Taleb's definition, as made up of three characteristics: (i) they are unexpected and rare, thereby lying outside the realm of regular expectations; (ii) their impacts are wide-ranging or extreme; (iii) they can only be explained after the fact. (The green swan 2020: 3). More technically put, black swans fit so-called fat tailed probability distributions (The green swan 2020: 3). Unlike Gaussian distributions, where extreme events are relatively rare, a fat tailed distribution places a higher probability on such events. Thus, a fat tailed distribution of financial losses means that large and potentially ruinous losses may occur with an unacceptably large probability. Due to their fat tails, a further problematic quality of such distributions is the inability to quantify this uncertainty in estimated losses since the variation of losses can be infinite (Hayes 2023). To look at the world as filled with 'black swans' is hence to look at the world as both catastrophic and unmeasurable, a dire situation that calls for 'alternative epistemologies of risk, grounded in the acknowledgment of uncertainty' (The green swan 2020: 3).

However, instead of representing a limit to the expertise of central banks, the figure of the black swan, and the theorizing of uncertainty it brings with it, is presented in the green swan document as something

that is meant to aid in 'framing the problem' that climate change poses to central banks (The green swan 2020: 6). Climate change is hence represented as a 'green swan' – that is, a 'climate black swan' (The green swan 2020: 3) – indicative of 'radical uncertainty associated with a physical, social and economic phenomenon that is constantly changing and involves complex dynamics and chain reactions' (The green swan 2020: iii). It is 'a new type of systemic risk' made up of 'interacting, nonlinear, fundamentally unpredictable, environmental, social, economic and geopolitical dynamics' (The green swan 2020: 6).

To define such 'climate risks', 'The green swan' makes use of the now highly referenced speech, 'Breaking the tragedy of the horizon', given in 2015 by former governor of the Bank of England, Mark Carney. Speaking in front of the insurance and reinsurance market, Lloyd's of London, considered to be the heart of the global insurance industry, Carney (2015) made the claim that climate change poses the risk of creating financial crisis if not taken into account by financial professionals. To explain how climate change could create financial crisis, Carney's speech established two main subcategories for how 'climate risk' should be understood, 'physical risks' and 'transition risks', which 'The green swan' also makes use of. Physical risks 'represent the economic costs and financial losses due to increasing frequency and severity of climate-related weather events (e.g. storms, floods or heat waves) and the effects of long-term changes in climate patterns (e.g. ocean acidification, rising sea levels or changes in precipitation)' (The green swan 2020: 17). Transition risks, on the other hand, 'are associated with the uncertain financial impacts that could result from a rapid low-carbon transition, including policy changes, reputational impacts, technological breakthroughs or limitations, and shifts in market preferences and social norms' (The green swan 2020: 18). Notably, while the so-called physical risks are related to changes in the climate itself and the so-called transition risks are related to changes in the political climate (be it policy reforms or shifts in social norms), what these risks are fundamentally about is how climate change can create potentially extreme financial losses. Related to the final category, transition risks, the main issue is 'stranded assets' (The green swan 2020: 18), meaning, for example, fossil fuels that cannot be taken out of the ground as a result of political changes and therefore become 'devalued' (The green swan 2020: 19).

The possibility of such a large-scale devaluation is then why climate change may create a financial crisis; again, 'The green swan' quotes Mark Carney who called it a 'climate Minsky moment' (Carney 2016: 2). Such a 'Minsky moment', named after the economist Hyman Minsky, refers to the paradox that when markets seem stable, the perception of this very stability may fuel excessive risk-taking and speculation, creating an internal market dynamic that consequently

may lead to an abrupt and unexpected crash (Ganti 2024). There is some kinship between the notion of black swans and the Minsky moment in that they both build on the idea of extreme and detrimental events happening in situations where prior events have not held signs of warning. In fact, in *The Black Swan*, Taleb (2007: 78) refers to Hyman Minsky as someone who, like him, emphasizes 'fundamental uncertainty' and, because of this, has become a sort of misfit, placed 'outside the mainstream economic departments'. In the green swan, the connection between the two notions is also made by saying that 'green swans' are both 'climate black swans' (The green swan 2020: 3) and 'climate Minsky moments' (The green swan 2020: 42).

What these different conceptualizations of uncertainty show is that even if uncertainty may function as a critique of central bank expertise, it is put to work in 'The green swan' to highlight instead the importance of central banks. Presented as a form of uncertainty that can create a financial crisis, climate change becomes an issue for central banks, as central banks have a mandate to uphold financial stability and therefore need to deal with the instability caused by climate change. As it is put, the uncertainty of the issue, or in more technical terms, the existence of 'fat tailed probability distributions', suggests a need for regulation in financial markets (The green swan 2020: 3). However, building from a theory that to a large degree refutes this type of expertise, it is not clear how to proceed, even if governing climate change has been fitted into central bank mandates. As we will see, a twisting of the uncertainty is needed to make it not an ontological problem but a knowledge problem, solvable by expertise.

Uncertainty as an epistemological obstacle

The uncertainty inherent in the black swan theory does pose some quite serious concerns for the possibility of modelling the economic consequences of climate change. Building on this, 'The green swan' develops a critique of a variety of economic solutions to climate change, largely denouncing the viability of economic modelling, precisely because the issue is thought to be too complex and uncertain to fit into these models. Nonetheless, this critique is not presented as a limit to central bank expertise. Rather, 'The green swan' turns the critique of the black swan from a critique of expertise to a critique of modelling, where expertise is in fact crucial to reframe the issue to make it knowable.

Developing on what the understanding of uncertainty means for the possibility of economic modelling, 'The green swan' puts forward a critique of the proposed solutions to climate change made by 'mainstream economics' or 'economic textbooks' (The green swan 2020: 6–7). This so-called mainstream view is presented as one that

takes climate change to be 'an externality that, as such, should be dealt with through publicly imposed Pigovian carbon taxes in order to internalise the climate externalities' (The green swan 2020: 6). Taking climate change to be a negative externality that can be given a price has indeed been a standard way of addressing climate change economically. Defined in economic terms, a negative externality refers to some negative effect that a transaction of an economic good has on a third party who did not take part in the initial transaction (Kenton 2024). While this solution would work in 'a perfect Walrasian world' – meaning a world where markets work perfectly according to equilibrium theory – it is not likely that it will be possible to find the right data to set a correct price on carbon, 'The green swan' argues, because of the 'complexity' and 'uncertainty' of the issue (The green swan 2020: 6). The criticism of pricing externalities is then a criticism of state-based solutions, which aim at imposing carbon taxes, but also of market-based solutions, which rely on such pricing.

Instead of trying to find the right data to set a correct price, 'The green swan' notes that 'A consensus is emerging among central banks, supervisors and practitioners' to use 'future-looking, scenario-based methodologies' to work on climate risks (The green swan 2020: 22). In fact, one of the main ways climate change has been taken into central banking is through the so-called 'scenario mappings' developed by another central bank nexus, the Network of Central Banks and Supervisors for Greening the Financial System (NGFS), of which both Banque de France and the BIS are founding members.

Since it saw the light of day in 2017, the NGFS has become an influential actor in financial spheres and has published a significant number of reports on how climate change can lead to financial crisis and therefore needs to be taken into consideration by central banks (NGFS 2018).[3] Their proposal for how to take in climate risks has been through these scenario mappings, which 'The green swan' describes as seeking to 'set up plausible hypotheses for the future', contrasting 'traditional' or 'probabilistic approaches to financial risk management' (The green swan 2020: 22). It is beyond the scope of this article to go into detail on how the NGFS 'scenario mappings' are set up (but see for instance: Täger 2022; Violle (forthcoming)). For our purpose here, it suffices to note how these scenarios are attempts to model the economic consequences (or risks) of climate change into the future and move away from a type of modelling that works with historical data.

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[3] NGFS was established under the One Plant Summit, held in Paris on 12 December 2017, exactly two years to the day after the Paris Agreement, with a stated focus on developing financial solutions for aiding the green transition. Since its inception, it has grown quickly, and as of 29 May 2024, NGFS consists of 141 members and 21 observers (NGFS 2019c).

The focus on uncertainty is also phrased quite explicitly in the 'scenarios portal' of the NGFS (2024), where the visitor is met with the words: 'The future is uncertain. The NGFS climate scenarios provide a window into different plausible futures.' In the NGFS reports, climate change is also presented as uncertainty as opposed to measurable risk, related both to the development of the physical impacts of climate change itself and to the way these changes will affect the economy through 'complex transmission channels' (NGFS 2019a). Following on from this, the NGFS puts forth a critique of 'macroeconomic models', which are thought to be unable to 'accurately predict the economic and financial impact of climate change' (NGFS 2019a: 4). One particular set of models that is critically scrutinized are integrated assessment models (IAMs), which have long been standard when analysing connections between economic activity and climate change on a systemic scale. These models cover a variety of approaches and are widely used (for example, by the IPCC) to show how changes in our climate affect the economy and vice versa. Generally, they combine climate science, showing how greenhouse gas emissions affect temperature increases, with an economic module that links these temperature increases to economic outcomes and policy (see, for instance, Cointe et al. 2019). Ultimately, these models are meant to show how the economy and the climate coevolve.

Several criticisms of IAMs are presented in the NGFS reports, related to the models' treatment of uncertainty, explained technically in that 'IAMs are typically recursive dynamic general equilibrium models solved deterministically' (NGFS 2019b: 4). Specifically, the fact that they are equilibrium models indicates that they assume a state of normality, which is no longer taken to hold under uncertainty. 'The green swan' follows up on this criticism of IAMs and is even more denouncing, stating that 'the deep uncertainty related to physical and transition risks means that both the neoclassical approach of most IAMs and alternative approaches such as demand-led and non-equilibrium models will remain unable to capture many forces triggered by climate change' (The green swan 2020: 27). As it is put, IAMs 'can be used to obtain almost any result one desires' and are thus 'grossly misleading' (The green swan. 2020: 71). Finally, even if the establishment of the NGFS is brought out as a positive development, the NGFS scenario mappings are also placed under critique because, since they build on IAMs, they 'inevitably inherit all the limitations of the climate-economic models' (The green swan 2020:

33). The conclusion becomes that what is needed is to go 'beyond models' (The green swan 2020: 43).[4]

In this way, 'The green swan' performs a fundamental critique of the ability to economically model climate change, including solutions proposed by central banks; but this does not mean that it presents the issue as *unknowable*. Rather, what we are faced with is an 'epistemological obstacle' (The green swan 2020: 21). This reference to the French philosopher of science Gaston Bachelard (1993) indicates that the current problem with developing models is not immediately a technical problem tied to 'the difficulty or complexity inherent to the object studied (e.g. measuring climate-related risks) but to the difficulty related to the need of redefining the problem' (The green swan 2020: 21). Put differently, the epistemological obstacle does not indicate that the uncertainty of the issue is so great that it can *never* be known, but that the current understanding of the problem poses a hindrance to knowing it. Or, the models are the obstacle, since 'scientific methods and intellectual habits that were useful and healthy under certain circumstances' have now become increasingly 'problematic' to the extent that they 'hamper scientific research' (The green swan 2020: 21).

One way to understand this move in 'The green swan' is to see how it moves the critique of uncertainty from marking a limit to the possibility of knowledge, and hence the possibility of expertise on this knowledge, to a critique of models. Unlike the notion of uncertainty put forth by the black swan, which questions not only knowledge but also expertise, uncertainty as an epistemic obstacle upholds the importance of expertise and places the problem with current methods. This latter uncertainty is then of a different sort than the one we find in the figure of the black swan, as it does not characterize a form of precondition to knowledge as such, but only within the current way of thinking about the issue (a reference to Kuhn's (1997) paradigm shifts is used to make its point (The green swan 2020: 21)). 'The green swan' hence works as a tool of critique by twisting the critique of expertise to separate the authority in this expertise from the models it makes use of. The ambivalence that arises in simultaneously promoting and criticizing the NGFS can be taken to be a result of this separation, commending the authority of the network and their way of working but not the specific models. In fact, the separation showcases an interesting effect of 'The green swan's use of critique as it allows for being critical of the modelling behind scenario-mapping while equally promoting the future-oriented work done by central banks.

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[4] It should be noted here that there exist several different types of IAMs and that the original models developed by Nordhaus, for instance, differ from the current models used by the IPCC. In 'The green swan', different IAMs are mentioned, but since they are all subjugated to the same critique, their differences are not elaborated on here. See, for instance, Cointe et al. (2019) for more on the heterogeneity of IAMs.

Uncertainty as the certainty of crisis

So far, I have shown how 'The green swan' puts forth a critique of economic solutions to climate change, taking care to separate it from the authority of central banks. The critique of modelling, however, leads to another problem as it pushes central banks into a more explicit political role, which is highlighted as problematic in 'The green swan'. I argue that to resolve this 'The green swan' works as a 'tool of valuation' that aims to make financial climate risk into a form of general 'good' that must be managed by financial actors and by climate policy makers. I propose to understand this move as one setting up a 'good economy', which turns climate change into a financial risk issue and further proposes to govern this risk as a 'good' rather than through either modelling or more explicit political climate action on the part of central banks.

I have so far not touched on one element of the figure of the green swan, which makes it quite different from what Taleb had in mind when conceptualizing his black swans. Because even if green swans fit the image of black swans in that they are unlikely, extreme, and unpredictable, 'The green swan' states that the effects of climate change will materialize with 'a high degree of certainty' (The green swan 2020: 3). That is, even if green swans are both unlikely and unpredictable, they are also to some extent certain, and thus the figure of the green swan takes a somewhat paradoxical shape. Not only is there 'certainty about the need for ambitious actions despite prevailing uncertainty regarding the timing and nature of impacts of climate change', but it is also the case that 'climate catastrophes are even more serious than most systemic financial crises: they could pose an existential threat to humanity, as increasingly emphasized by climate scientists' (The green swan 2020: 3). The certainty is thus presented as both an epistemological question (something we know will happen) and a normative question (an existential threat). Whether this construction holds theoretical sense, particularly in saying that something certain cannot be predicted statistically, will not be the issue here. The goal is rather to follow the figure of the green swan and see what effects this construction creates.

A first thing to notice is that since the form of economic governance that relies solely on modelling has been established as faulty, the certainty of the climate crisis and the consequent need for action push central banks towards taking more explicit climate action, which is framed as problematic in 'The green swan.' As it is put, central banks 'cannot resort to simply measuring risks (hoping that this will catalyse sufficient action from all players) and wait for other government agencies to jump into action', as 'this could expose central banks to the real risk that they will not be able to deliver on their mandates of financial and price stability' (The green swan 2020: 47). Conversely, it is framed as problematic if central banks, as a result of this, start

entering a more political role that actively supports green fiscal policy, for example by conducting 'green quantitative easing' (The green swan 2020: 47), that is, making non-green capital more expensive. Even if there is a 'growing social demand' for this, as it is put, extending the central bank mandate into this role is presented as unwanted because it can 'overburden' the mandates and requires 'new sociopolitical equilibria, reputation and credibility' (The green swan 2020: 47). Instead, the stated goal is to allow central banks to work on climate change with the objective of preserving their proposed non-political role (The green swan 2020: 48).

As I suggest in this article, 'The green swan' document itself can be understood as an attempt at governing climate risk without either modelling or explicit climate action. Rather, by stating that climate risks are certain, 'The green swan' aims to *value* the financial risks from climate change. It is in this way that I propose that the document can be taken to be a 'tool of valuation', aiming to value financial climate risk as a 'good' to create a performative response to this valuation and thus manage these risks more broadly. This move can be seen not just in how 'The green swan' uses normative language to promote precaution on climate change, but also in how stating the certainty of crisis is assumed to provoke a precautionary response. Believing in the certainty of the climate crisis is, in fact, made out to be a risk management exercise, or, as it is put, 'a hedging strategy against the possibility of green swan events' (The green swan 2020: 8). The strategy to manage risk based on 'faith' is attributed to the French philosopher, mathematician, and physicist Pascal, who argued that 'rational people should believe in God as a "pari" or bet. They would incur small losses of pleasure (by accepting to live a life without excessive pleasures), which would be more than offset by infinite gains (eternity in heaven) if God existed' (The green swan 2020: 8). Thus, 'a pure self-interested risk management strategy recommends buying the proper insurance of ambitious climate policies as a kind of precautionary principle' (The green swan 2020: 8). Another alternative risk management strategy that 'The green swan' brings in is 'Enlightened doomsaying' (*catastrophisme éclairé*), taken from the French philosopher of science Jean Pierre Dupuy (2012). And it could be read as precisely what 'The green swan' attempts to do: 'imagining oneself in a catastrophic future to raise awareness and trigger immediate action so that this future does not take place' (The green swan 2020: 8). It is in this way, I argue, that 'The green swan' works as a tool to value the future as a form of moral horizon to spur a precautionary response even in the absence of precise knowledge.

An apt question is then who is imagined to take this precautionary action. After 'The green swan' was published in 2020, an annual conference has been held in its name, gathering prominent speakers ranging from Al Gore to Joseph Stiglitz to Zhou Xiaochuan, the

former Governor of People's Bank of China. In the opening address at the first edition of the conference in 2021, Luiz Pereira da Silva, who was then Deputy General Manager of the BIS and one of the authors behind 'The green swan', listed the actors the conference gathered: 'policymakers, the community of central banks and regulators in Europe, Asia, Africa and the Americas as well as international financial institutions and development banks. … investors, asset managers, insurance and commercial banks, innovators, researchers in academia, engineers, consumers and, of course, *you* in the audience' (BIS 2022: 4). The extensive list effectively made the point that managing the financial risks of climate change is not the task of central banks alone, rather, the figure of the green swan makes climate risk out to be a more general 'good' for all these actors.

It is this framing of the financial risks from climate change as a 'good' that I have suggested to call a 'good economy', in order to highlight how it both turns climate change into an economic issue, as a financial risk, and aims to govern this risk performatively by making it into a general 'good'. Importantly, the 'good' at stake is at once the stability of the climate and the financial system. 'The green swan' states this quite explicitly: 'financial and climate stability are two increasingly interdependent public goods' (The green swan 2020: 66). This demonstrates a salient effect of how 'The green swan' mobilizes uncertainty. While uncertainty complicates modelling, it also enables the linking together of different issues, since in a world of 'complex adaptive systems', nothing is separate from anything else, and everything must be dealt with in relation to everything else. This interconnection of issues is why climate change becomes an issue for central banks to begin with. It is also why maintaining the stability of the financial system can become a 'good' tied to the normativity inherent in stabilizing the climate, bringing financial risk into the politics of climate change as a 'good economy'.

Conclusion

In this article, I have shown how climate change is now being considered an issue for central banks, following a shift in the understanding of financial risk that has been identified following the 2008 financial crisis. I have shown how central banks, faced with questioning what exactly constitutes financial risk and with a delegitimization of the probabilistic future, understand climate change through the lens of complexity theory and uncertainty, rather than as measurable risk. Through a detailed analysis of a document published by the Bank for International Settlements and Banque de France (2020) called 'The green swan: central banking and financial stability in the age of climate change', I have shown how climate change here takes the shape of a specific form of risk – a 'green swan'. I have

detailed how this figure builds on the influential notion of the 'black swan' developed by complexity theorist Nicholas Nassim Taleb (2007), referring to an unlikely and extreme event that cannot be predicted. In my analysis, I have specifically sought to draw attention to the critique implicit in this notion. Taleb, and to some extent the field of complexity theory more generally, have, with their view of the world as uncertain, questioned the possibility of economic expertise; since the future is viewed as fundamentally unmeasurable, economic modelling – and the central bank experts who make use of them – will fall short in predicting it. As I have shown, this critique is twisted in the figure of the green swan, turning the uncertainty into a critique of modelling but not of expertise as such, hence separating authority in the expertise from the models it makes use of. In this way, I have shown how the uncertainty present in 'The green swan' is no longer a limit to knowledge but an 'epistemic obstacle', where this expertise is in fact needed to fend off crisis and to make climate change knowable.

As I have shown, uncertainty changes in the figure of the green swan to make the point that even if statistically improbable, the climate crisis will happen with catastrophic certainty. This opens for a dilemma where central banks are made to choose between a 'non-political' or 'expert' role, working with models (which have been deemed faulty), and a more explicitly political role, supporting green policy and actively funding the green transition. To avoid this, I have argued, 'The green swan' document uses the certainty of crisis to propose a third route by working as a 'tool of valuation', aiming to make financial climate risk into a 'good' so that these risks are taken into account by both financial and political actors. I have suggested to understand this move by 'The green swan' as one aiming to set up a 'good economy' to deal with climate change. It is a 'good economy' in the sense that it first turns climate change into an economic issue about financial risk, and second proposes to work on this issue by valuing it as a 'good'. With this, I have sought to make the point that uncertainty should not be taken to be something simply standing in the way of economic knowledge. Rather, the flexibility of an uncertain world can be mobilized to turn things into economic issues, and to make these new economic issues 'good' by entangling them with the 'good' of other issues. 'The green swan' shows how climate change has become an issue for central banks but also how they are working to make financial risks from climate change important in the broader politics of climate change. What will come of these efforts, and whether the 'good' of the climate and the 'good' of the financial system are in fact in accordance with one another, is, of course, yet to be seen. And so too are the ambitions of green central banking, which are consequently in the process of being laid out.

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