



THE LONDON SCHOOL
OF ECONOMICS AND
POLITICAL SCIENCE ■

Constructing climate risk: how finance governs its relationship with the planet's climate

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A thesis submitted to the Department of Geography & Environment of the London School of
Economics and Political Science for the degree of Doctor of Philosophy,

London, June 2022

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Abstract

This thesis is driven by the question of how finance governs its relationship with the planet's climate. Structuring this emergent governance experiment is a new type of risk: climate risk. Using Actor-Network Theory (ANT), this thesis problematises climate risk by tracing its construction. Theoretically, the thesis advances debates around the potentials and limits of ANT in the context of financial governance. It goes beyond ANT by formulating a wider conceptual approach to climate risk. Empirically, this research uncovers the genesis of a governance tool pivotal to the construction of climate risk: the disclosure framework developed by the Task Force on Climate-related Financial Disclosures (TCFD). The first paper traces the translation of climate risk from a contested claim into a fact leading to the creation of the TCFD. Novel to the literature, it foregrounds the critical role of face-to-face contact and proposes an extension of ANT's conception of materiality to account for human interaction. The second paper follows the development of the TCFD's global disclosure framework. Tracing shifting conflict lines, it draws into question conceptions of industry interest representation and argues for the need to take individuals' personal interests seriously. The third paper focuses on one of the TCFD's key recommendations: the conduct of climate scenario analysis. Advancing literatures on the modelling and imagination of futures, the paper argues that the process of designing global reference scenarios produced exclusionary imperatives. These imperatives constrain both the imagination of climate and financial catastrophes, and solution pathways. The final paper contextualises the thesis by proposing an integrative research agenda anchored in the Callonian concept of economization and thus calling for a sociology of climate risk. The thesis as a whole provides a forensic interrogation of the socio-technical politics of defining climate risk. Furthermore, it illuminates the limits and potentials of the climate risk frame and thus of finance's role in the Anthropocene.

Acknowledgements

This PhD would simply not have happened without my primary supervisor, Richard. I am deeply grateful for his invaluable guidance, how he challenged me, and how he gave me the intellectual freedom I gained so much from over the past years. His mentorship and care extended beyond the duties of a supervisor and provided me with crucial support – whether as teacher, researcher, subwarden, or PhD student.

This PhD also owes much to my secondary supervisors. Myung-Ae brought direction into my thinking around ANT at a stage of my PhD where I could not see the wood for the trees. Michael's deep knowledge and ever so thoughtful comments enriched my work throughout the PhD well before he joined my supervisory team.

My affiliation with both the Department for Geography & Environment and the Grantham Research Institute allowed me to meet and learn from scholars and colleagues who inspired me in multiple ways. I am grateful for Kasia's critical thoughts on my work and her precious guidance on how to navigate academia. Nick was not just instrumental in helping me enter the field, but he also gave me the opportunity to learn and act outside of the academy. For the many conversations with and insights from him and also from Sini I am very grateful.

This PhD of course owes greatly to the many interviewees and participants who shared their thoughts and experiences with me and who carved out some space in their busy schedules to support academic research. I am deeply grateful and hope that they find the results of my work to be useful or interesting.

I would have felt lost far more often than I did anyway throughout this PhD if it had not been for a group of friends walking the path with me. For their feedback on my ideas and writings, for their personal support, and for their inspiration I want to thank Fernanda, Janna, Jon, and Yarden.

The unconditional support of my parents did not only carry me through this PhD but equipped me with the curiosity and the confidence to pursue an academic path in the first place. For that and for so much more I am forever grateful.

Doing this PhD in London connected me with people who this PhD indirectly owes a lot to. I want to thank Clara for providing a refuge for me to reset and recharge. And a big shout-out to my Tower Hamlets LG and the LA Casuals for showing and reminding me of what I want to dedicate this PhD to:

Another world is possible.

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1. Introduction

From the very beginning of my undergraduate studies in political science and history, my academic attention was focused on environmental issues. The physical inevitability and ubiquity of societies' reliance on the environment fascinated me. Only during my master's studies, a research assistant job with a research group working on transnational financial governance pushed me to develop an interest in a very different facet of social life: the role of finance in society. Influenced by the financialization and organisational field literature, in my master's thesis I tried to understand how these two spheres of finance and the environment connect. Asking the question of how financial markets define environmental sustainability, I came to the realization that this concept so central in environmental politics is marginal at best within finance. What really mattered in a post-2008 world was risk. What I did not understand after my master's degree, however, was what that meant for the relationship between finance and the natural environment. I still felt like I had only understood the terminology of this relationship but not how finance was actively organising it. This feeling led me to my PhD work and to (the City of) London. Roughly halfway through my PhD, it also led me back to the beginning, to my master's thesis, when I came to understand that the concept of risk was not just the terminology but the dominant logic behind how this relationship between finance and the environment is organised.

A multi-year research project like a PhD is rarely a linear process as straightforward and unidirectional as some introductions might suggest. This introduction attempts to provide transparency on the non-linearities of this PhD research while inducting the reader to topic, conceptual framework, methods, and structure of this thesis.

1.1. The Anthropocene and finance

This PhD thesis seeks to advance our understanding of how two key phenomena that define the 21st century intersect: the Anthropocene and the rising role of finance.

1.1.1. The Anthropocene and climate change

The concept of the Anthropocene coined by Crutzen and Stoermer (2000) captures the idea that human activity has become such a dominant driving force of environmental dynamics that it warrants the definition of a new age. It has become increasingly clear over the past decades that this human activity is destabilising multiple ecological equilibria and is breaching planetary boundaries (Rockström et al. 2009; Steffen et al. 2015). Consequently, not just local or regional ecosystems might undergo sudden changes but the entire global earth system faces the danger of planetary tipping points (Barnosky et al. 2012). Drastic effects on life on earth are visible already in the form of e.g. a sixth mass extinction (Cardoso et al. 2020; Ceballos, Ehrlich, and Dirzo 2017).

Climate change as a key dimension of these anthropogenic changes to the planet has so far received most attention across different societal spheres. The annual climate diplomacy conference – the conference of the parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) – reconvened for the 26th time in 2021 and attracts thousands of diplomats, lobbyists, and other stakeholders every year. This concentration of interest in climate change in the political realm is matched by keen attention in mainstream media and academia across continents (Sklair 2020). While reasons for such concerted focus on the climate change dimension of the Anthropocene are complex, the magnitude of the possible societal effects of climate change is a key driver.

First, the magnitude of climate effects keeps worsening as greenhouse gas (GHG) emissions are increasing, not declining, let alone approaching a level ensuring climate stability (IPCC 2022). Second, impacts from climate change are global – yet unequally distributed – and are set to increasingly hamper humans' ability to meet basic needs such as access to water and food (Deutsch et al. 2018; FAO 2016; 2021; IPCC 2021; Jägermeyr et al. 2021; Rojas et al. 2019). Third, changes to the climate and subsequent effects on life on earth are or can become irreversible as well as uncontrollable due to climate system tipping points (Lenton et al. 2019) as well as positive feedback loops in the earth system such as the thawing of permafrost (González-Eguino and Neumann 2016) or ocean acidification (Breider et al. 2019) both triggered by and in turn triggering increasing GHG emissions.

These dynamics and trends have driven some climate scientists to speak of a “human imperative of stabilizing global climate change at 1.5°C” (Hoegh-Guldberg et al. 2019) given the significant differences in impacts even between 1.5°C and 2°C of global average surface temperature warming by the year 2100 compared to preindustrial levels (Schleussner et al. 2016). Meeting this temperature goal of 1.5°C – commonly considered ambitious – does not preclude the possibility, however, of temperatures exceeding 1.5°C locally or regionally and thus triggering ecosystem collapses in affected locations (Seneviratne et al. 2018).

Without diminishing the urgency and relevance of other ecological crises such as the rapid decline in biodiversity, this PhD is guided by the priority that climate change has been assigned to by politics, media, and academia and thus focuses on the climate dimension of the Anthropocene.

It is not only the prioritisation of climate change within the myriad of socio-environmental relations captured by the idea of the Anthropocene that is influenced by politics and other layers of societal life. Nothing about the way we understand what is called ‘climate change’ or the ‘Anthropocene’ escapes its social embeddedness (e.g. Hulme 2021; Miller 2004). The way climate science is organised can pose questions on equity and exclusion (e.g. Corbera et al. 2015; Hughes and Paterson 2017) and narratives of the Anthropocene can raise concerns about depoliticization and the foreclosure of courses of action

(e.g. Swyngedouw and Ernstson 2018). This PhD is not just aware of but driven by these conceptions of the social contingency of knowledge and knowing. Yet, it takes the broad consensus within the natural science community on the scale and urgency of the climate crisis as sufficient basis for concern and academic attention.

1.1.2. Finance

The current phase not in the earth's but in the economy's history is marked by the rising role of private finance starting in the 1980s. Capital accumulation has been shifting from manufacturing and other sectors towards the financial sector thus growing finance's share in the economy. This trend has been accompanied by a growing spread and reach of financial rationalities and financial means of control (Arrighi 2010; Birch and Muniesa 2020; Carruthers 2015; Chiapello 2015; Greenwood and Scharfstein 2013; Krippner 2011; Langley 2020). This dual growth in size and reach of finance primarily but not exclusively (see e.g. Bonizzi 2013) in North America and Europe is affecting and transforming almost all layers of societal life.

On the individual level, everyday behaviour is being re-calibrated, for instance, where people get enrolled in micro-finance schemes in South East Asia (Mader 2015). Beyond effects on individuals, finance has also re-shaped the most fundamental organisational form in markets, the firm in, e.g. the US (Appelbaum and Batt 2014; Krippner 2005). Finance also reconfigures whole market dynamics, e.g. by structuring the valuation and thus distribution of the basic human needs for housing and shelter in European real estate markets (Botzem and Dobusch 2017). Even state institutions do not remain insulated from the effects of financialization as shown by e.g. entire nation states prioritising financial health and stability during the Eurozone crisis (Streeck 2018) or the escape of sizable amounts of wealth from tax authorities through a globalised financial system (Damgaard, Elkjaer, and Johannessen 2019; OECD 2013).

1.1.3. The finance-climate nexus

Given the reach, scope, and magnitude of both developments – climate change and the rise of finance –, it is inevitable for them to interact in multiple ways and layers, forming a finance-climate nexus. This thesis is not concerned, however, with all these interactions, e.g. with an analysis of how or whether these two forces amplify or inhibit each other. Instead, it is interested in the reflexive attempt to govern and organise these interactions. This PhD thus seeks to shed some light on the potentials being nurtured and paths being chartered for the finance-climate nexus, looking forwards rather than backwards. The question driving this research endeavour is therefore: How does finance govern and organise its relationship with the planet's climate?

1.2. The TCFD as crucial case study

During the very early stages of this PhD between September and December 2017, the landscape of governance and organising attempts around the relationship between finance and climate change was significantly less developed than it is today. Given the global character of both finance and climate change, the selection of a case study of global significance seemed appropriate. At the time, three governance initiatives with both global reach and authority were emerging in the finance-climate nexus: First, the G20 Green Finance Study Group which, however, had significantly slowed down its activities after the election of Donald Trump as president of the United States; second, the Network for Greening the Financial System (NGFS) founded by eight central banks and financial supervisors in December 2017 – partially in reaction to the deadlock on the G20 level; third, the Financial Stability Board's (FSB) Task Force on Climate-related Financial Disclosures (TCFD). With the Study Group becoming a 'lame duck', the NGFS only just having been announced, and the TCFD's first official policy just having been endorsed by the G20 in summer 2017, the TCFD presented itself as most promising choice for a potentially crucial case study.

The TCFD was convened by the FSB, the global financial markets regulator replacing the Financial Stability Forum after its failure around the 2008 financial crisis (Helleiner 2010; Mackintosh 2017; Moschella 2013). Its task was to develop a framework for both corporate and financial actors to disclose climate-related financial information. This information was considered to be crucial for capital market actors to better assess climate-related risks and opportunities (Carney 2015; 2016; TCFD 2017). Hence, the TCFD's role in the finance-climate nexus was to define what kind of information should be made available to inform investment decisions thus constituting a significant part of the knowledge base steering capital allocation. The TCFD's final recommendations did not only present a list of indicators or metrics for companies to disclose but more crucially provided categories mapping types of climate-related information and related said categories to established practices and rationalities in finance, accounting, and management. Thus, the recommendations translated the issue of climate change into the language and rationalities of c-suite executives, financial analysts, and accountants.

Ex-post, the selection of the TCFD as crucial case with global reach and authority governing and organising the knowledge base of the finance-climate nexus can be justified further. The TCFD recommendations have become the basis for mandatory disclosure requirements across the globe from the UK to Tokyo and from the US to the EU (see e.g. TCFD 2021). They instructed the COP26 Private Finance Strategy (Carney 2020) and became a centre piece of the NGFS' first work programme (NGFS 2018). In fact, the TCFD has come to be considered so influential that it has inspired imitation by a Task Force on Nature-related Financial Disclosures – the TNFD – supported by various governments, development banks, and private actors.

Both the TCFD's institutional set-up and its mode of governing is paradigmatic for a dual trend in regulation. Its set-up locates it outside of the realm of state authority, making it an instance of private transnational governance. Its embeddedness in relations with the FSB as well as with other private organisations supplying resources and content inputs in turn makes it an element in a wider network of 'decentred', 'polycentric' or 'fragmented' governance (Biermann et al. 2009; Black 2001; Ostrom 2010). This set-up imprints on its governance mode since the lack of formal top-down state authority makes the TCFD reliant on alternative sources of authority and 'soft' regulation in the form of standards (Abbott and Snidal 2000; Black 2017; Hall and Biersteker 2002; Tamm Hallström and Boström 2010). In that sense, the TCFD is also a somewhat typical case of governing transnationally.

1.3. Situating the PhD in the academic literature: green finance, knowledge, and climate risk

The TCFD itself is too novel – and perhaps too opaque – to have attracted much scholarly attention. Apart from positivist assessments of the scope and quality of the TCFD recommendations' implementation (Bingler et al. 2022; Demaria and Rigot 2021; O'Dwyer and Unerman 2020), only Christophers (2017) has provided an analysis of the TCFD as a social phenomenon and as governance initiative. However, by discussing some of the theoretical limitations and potential biases of a disclosure-based approach to governing financial markets in general, his analysis remains theoretical and on a high level of abstraction.

Given the above, this PhD positions itself in the wider literature on the finance-climate nexus but limits itself to accounts of finance as inherently social rather than purely economic (see Black 2013). This literature in turn can be organised into topic-specific sub-streams which this section cannot do full justice to within the scope of this introduction. However, it flags two blind spot these sub-streams have in common – a lack of scholarship unpacking both knowledge production processes and the concept of climate risk – as well as a range of sensitivities nurtured by this literature and instructive for all papers in this PhD.

First, a literature on the origins and development paths of sustainable finance markets in different jurisdictions and geographies – broadly understood as finance which integrates non-financial considerations on e.g. human rights or environmental impacts into decision-making processes – is insightful in two ways: It both highlights the importance of state institutions in facilitating market creation and growth, and it sensitises to geographical differences and specificities (Bengtsson 2008; Crifo, Durand, and Gond 2019; Sakuma and Louche 2008). Both are relevant undercurrents especially in the first two papers of this PhD. Second, a wide literature on carbon markets draws attention to the significance of materiality and calculative devices. The former becomes significant where the virtuality

of carbon credits, i.e. their detachment from the physical reality of GHG emissions, necessary to facilitate market exchange gives rise to e.g. perverse incentives and unintended consequences (Bansal and Knox-Hayes 2013; Chiapello and Engels 2021; Knox-Hayes 2010). The latter – calculative devices – can facilitate this process and also become vessels for decisions with highly political implications per se such as how to commensurate different greenhouse gases (MacKenzie 2009; Skodvin 2012), becoming “a political technology” (Doganova 2021).

This political character of calculative devices in the broader sense – understanding calculation as qualculation (Callon and Law 2005) – is unpacked further in the literature on sustainability or ESG (environmental, social, and governance) ratings and labels for so-called sustainable products within finance such as green bonds. In a nutshell, this third sub-stream of literature problematises the contingent and situated nature of calculating and defining what is sustainable and what is not (Arjaliès and Durand 2019; Berg, Kölbel, and Rigobon 2019; Drempetic, Klein, and Zwergel 2019; Eccles, Lee, and Stroehle 2020; Entine 2003; Igalels and Gond 2005; Zarlowski 2007) while analysing how these labels – despite their problematic nature – affect company and investor behaviour (Chatterji and Toffel 2010; Clementino and Perkins 2020; Mackenzie, Rees, and Rodionova 2013; Slager and Chapple 2015; Slager and Gond 2020). Calculation thus constitutes a site of power and politics (Giamporcaro and Gond 2016). These findings on the prevalence and use of problematic calculative devices and labels in finance which, however, are organizationally useful, familiar or help grow markets (Cash 2018; Chelli and Gendron 2013; Lovell 2014; Perkins 2021) instructs thinking particularly in the last two papers of this PhD which zoom in on calculative practices.

Fourth, a sub-stream of literature has formed around multiple attempts to govern climate-related accounting and disclosure prior to the creation of the TCFD. Focusing on the limits and potentials of climate-related disclosure as governance instrument, multiple studies have shed doubts on disclosure being suitable for effectively governing financial markets (Ameli et al. 2020; Ameli, Kothari, and Grubb 2021; Christophers 2017). Often used field-level approaches converge in their findings of such disclosure initiatives being the result of entrepreneurial institutional work involving diverse networks of actors, but later being successively dominated by the interests of large corporations. Thus, disclosure guidelines eventually tend to prioritise the facilitation of efficiency gains, reputational benefits, and corporate management (Brown, Jong, and Levy 2009; Knox-Hayes and Levy 2011; Kolk, Levy, and Pinkse 2008; Levy, Szejnwald Brown, and Jong 2010). Studies tracking the constitution of disclosure and accounting standards on a micro-level and thus addressing the question of how such dominance is achieved are rare, however. Notable exceptions by Etzion and Ferraro (2010) and Ascui and Lovell (2012) point to the significance of how ways of knowing shape standards. Etzion and Ferraro (2010) show how the work of linguistically drawing analogies between sustainability and financial

accounting sets boundaries for sustainability standards while contributing to their legitimisation. Ascui and Lovell (2012) emphasise the multiplicity of ways to conceptualise carbon accounting and their roots in distinct professional epistemic communities. These two studies demonstrate both the significance of the knowledge dimension of disclosure governance as well as the value of micro-level inquiries to address questions of how and why disclosure and accounting standards took the form and character they did.

This hardly addressed cognitive dimension of sustainability disclosure and accounting governance, i.e. what, how and by whom certain knowledge becomes embodied in standards and frameworks (see e.g. Jacobsson 2002), appears as even wider gap when reviewing literature on financial accounting standard setting. Here, standard setters have shown to bring epistemic conceptions of accounting specific to their professional or cultural background into accounting standards. In particular, US specific conceptions such as decision-usefulness or fair value accounting have been found to thus become dominant e.g. in global accounting standards with significant political effects on e.g. wealth distribution and financial crisis dynamics (Allen and Ramanna 2013; Botzem 2012; Kurz 2009; Young 2006). Financial accounting standards thus do not simply embody neutral 'expert' knowledge but instead political and situated versions of accounting knowledge thus requiring an active maintenance of purely technical and 'expert' image in the face of challenges by alternative conceptions and knowledges (Young 2014). Such successful boundary work can naturalise particular knowledge and conceptions to the degree that alternative ideas and knowledges or obvious dissonance between knowledge and experience can be ignored (Durocher and Gendron 2011; Pelger 2016).

Thus, the finance-climate nexus literature problematises knowledge outputs in the context of sustainability ratings and labels; it notes the productive and political effects of particular knowledge in the context of carbon accounting; and it acknowledges the relevance of the cognitive layers of standard setting in sustainability accounting and disclosure – although not to the degree its sister literature on financial accounting standards settings does. However, there is a lack of scholarship tracing the processes of constructing this problematic, political, and productive knowledge. Such knowledge constructions processes are critical components of governance regimes, however, as they constitute the governance object, defining the very problem to be solved and thus appropriate solutions (Allan 2017; Barry 2012; Williams 2012). Furthermore, for the TCFD knowledge is simultaneously the primary governance tool – in the form of standards and frameworks – while information as key ingredient of knowledge constitutes its governance object. Thus, the nature of the research object and the gap in the literature call for a research approach centring knowledge.

While this focus on the cognitive dimension of governance, the constructive and constructed nature of knowledge in governing and organising the finance-climate nexus through the TCFD formed the

basis of this PhD, it underwent a process of refinement and concretisation in the field. This process was as much driven by empirical observation as it was by further engagement with the academic literature – as common in qualitative empirical research (see e.g. Lund 2014). It led this PhD research to focus on the knowledge object at the heart of the TCFD – and of a whole emergent governance regime: climate risk.

The observation that finance often sees and understands climate change through the lens of risk is – in principle – not new to the finance-climate nexus literature. However, where this risk lens is being unpacked, highlighting the problematic, political, and productive role of calculative devices and practices, it is being attributed to and therefore siloed in the insurance sector where the transformation of physical hazards into mathematical risks is not a new phenomenon (see e.g. Bracking 2019; Elliott 2021; Gray 2021). Outside of insurance, risk has been acknowledged as pervasive frame to understand climate change in investment practice (Christophers 2019), central banking (Langley and Morris 2020), and sustainability ratings (Boiral, Talbot, and Brotherton 2020). In all cases, however, climate risk as frame or heuristic device is neither foregrounded nor interrogated in depth. This is particularly problematic as Nyberg and Wright (2016) have shown how certain corporate constructions of climate risk can mute voices in the climate change discourse and perpetuate a status quo beneficial to those defining what climate risk is. Meanwhile, positivist literature in finance nearly exclusively approaches climate change through a risk lens (see e.g. Venturini 2022) mirroring the cognitive approach in private finance and central banking as well as the nearly exclusive focus of the TCFD on climate-related risks. With observations in the field further confirming the nearly ubiquitous nature of the risk frame, climate risk became the knowledge object whose construction this PhD came to trace.

1.4. Conceptual framework and methodology

1.4.1. Tracing knowledge construction

Under the umbrella of science and technology studies (STS) a variety of conceptualisations tailored to understand the construction of technical and specialist knowledge has been developed. With the TCFD being an initiative presented as ‘expert’ body (see e.g. TCFD 2017, 3) producing exactly such technical and specialist knowledge, an STS approach matches the nature of the research object. At the heart of STS lies what Jasanoff (2004b) calls the *idiom of co-production*, i.e. the tenet that knowledge, science, and technology both produce and are produced by social order and thus inextricably linked with relations of power and control. Beyond this core lies a highly diverse landscape of STS approaches which can be – somewhat crudely – separated into approaches foregrounding either the materiality of co-production or co-production’s institutional embeddedness (see e.g. Jasanoff 2004a).

While both schools within STS provide crucial theoretical insights into processes of knowledge construction, the latter – chiefly represented by the work of Sheila Jasanoff – does not match well certain key aspects of the research object of interest while the former does. First, the TCFD is most obviously an initiative for, by, and within financial markets. While Jasanoffian STS has been developed in and for a wide range of issue fields from chemical hazards to genetically modified organisms and plastic surgeries (see e.g. Jasanoff 2012), the realm of finance is not one of them. The school of STS foregrounding materiality, however, has inspired and developed into an entire new sub-discipline of sociological inquiry into the role of technologies and knowledge in financial markets and the wider economy (Callon 1999; Callon, Millo, and Muniesa 2008; Doganova 2020; MacKenzie, Muniesa, and Siu 2007; Preda 2008). Second, institutional approaches within STS often focus their analysis on the macro-level of entire nation states (see e.g. Jasanoff and Kim 2015) and nationally specific “civic epistemologies” (Jasanoff 2012, chapter 1), i.e. national preferences for knowledge production. The TCFD, however, as a transnational governance initiative is neither firmly located within a national institutional set-up nor is its production of knowledge carried out in an entire national public. To the contrary, the TCFD’s knowledge production was broadly dominated by about three dozen individuals, calling for a conceptual framework prioritising the micro-level. Institutional approaches to STS have, however, also produced tremendously insightful research into micro-level negotiations of knowledge and expertise leading to further points of friction between this school within STS and the research object at hand.

Detailed accounts of court cases have dealt with questions of how and when certain kinds of specialists become accepted as experts on a given aspect of a trial and what type of knowledge becomes legitimised as expertise (Jasanoff 2012, chapter 11; Lynch 2004). While deeply insightful in their own right, these instances of micro-level research deal with open confrontations, knowledge contestations made explicit and obvious by two formally defined parties opposing each other in court. This focus on open contestations also characterises most macro-level studies focusing on knowledge controversies in the open, e.g. around major industrial accidents. Furthermore, these contestations typically unfold between distinct groups of specialists, e.g. different professions, and thus different types of knowledge rather than within a single profession or discipline (see also Barry 2012, 326). The TCFD, however, is characterised by an extraordinary absence of public contestations as well as a certain homogeneity of ‘experts’ and ‘expertise’ centred on practitioner knowledge of climate-related disclosure resembling a post-political space (see e.g. Swyngedouw 2011). Thus, the nature of the TCFD seems to require a conceptual framework attuned to the silent, seemingly technical and intra-disciplinary contestations unfolding on a micro-level – which is the domain of the more materiality-focused approaches in STS (Latour 1987; Latour, Woolgar, and Salk 1986).

Lastly, the TCFD resembles other common modes of organising in financial markets in general and in sustainable finance in particular – as highlighted in the literature review above – in that it promotes and relies on calculative devices such as mathematical formulas and models (Callon, Millo, and Muniesa 2008). Such devices – which will be central in all but the very first paper of this PhD – take a backseat in most institutional approaches to STS while the materiality-focused school firmly integrates them into its conception of agency thus providing a fertile conceptual base from which to investigate their role in the context of the TCFD.

Thus, a more materiality-focused STS approach appears to fit the nature of the research object well. The following sub-section summarises how such an approach, more precisely how Actor-Network Theory (ANT), facilitates this research.

1.4.2. Actor-Network Theory

ANT is often defined negatively, i.e. by what it is not rather than by what it is – including sometimes by its own founders (see e.g. Latour 1999; Law 1999). Its constantly evolving and adapting nature makes a definite and comprehensive characterisation impossible. Thus, this section focuses on what ANT is for and in the context of this PhD thesis.

Less prescriptive than a theory (Latour 1999) but more than what some have called an “attitude” (Passoth and Rowland 2016, 54), the essence of ANT is better captured in its original name: a sociology of translation (Callon 1986). ANT provides a conceptual toolkit and a methodology to trace how knowledge claims, ideas, and technologies are literally translated, i.e. moved through time and/or space. Such translation is a process of mutual transformation of what is being translated and what it is being translated into. “Translation is [thus] a process of replication and imitation *and* differentiation at the same time” (Barry 2013, 415). This methodology expresses itself in what Law and Singleton (2013, 491) call a sensibility: “Perhaps, then, ANT isn’t a theory. Perhaps it is better thought of as a sensibility to the materiality, relationality and uncertainty of practices”.

The first sensibility – to the materiality of practice – is a core pillar of ANT’s flat ontology which does not discriminate between the human and the non-human, the natural and the cultural. In the context of tracing knowledge production processes, this implies concretely that a focus on the purely discursive is insufficient to understand the genesis and change of knowledge claims. The material world plays a central role in knowledge construction as well (Mützel 2009). On a practical level, this clarifies the ontological position of objects and devices flagged as relevant in the context of the finance-climate nexus – a position which will become clearer in the light of the second sensibility but which can briefly be summarised as “objects too have agency” (Latour 2005, 63). More fundamentally, this sensibility – without taking a positivist stance – provides an epistemological basis for accepting and integrating

natural science outputs into this PhD research. While a fully discursive conception of scientific knowledge as entirely socially constructed might struggle to justify the reliance on findings in climate science, ANT's ontology of a stable but multiple material core unaltered and unalterable by social relations provides a firm basis for referring to natural science research (Latour 1987; 2005; Law 2008). Said research is of relevance both for the overall positioning and motivation of this PhD and for the third paper in this thesis on climate-related modelling.

The second sensibility – to the relationality of practice – constitutes the second pillar of ANT's ontology which foregrounds how the ties between actors and objects rather than their respective inherent essence defines what is. In the context of knowledge construction, this implies that a knowledge claim does not automatically become a fact and a technology does not automatically become a functioning machine by virtue of its essence. How a statement relates to other statements and how one component of a technology relates to other components decides over its status (Latour 1987) as e.g. Collins, Cowell, and Flynn (2009) show for the case of ecological footprinting. Thus, knowledge and definitions of problems, entities, and solutions are therefore socio-technically contingent and hence heterogeneous as e.g. Burgess, Clark, and Harrison (2000) show in their study of wetland management or Rutland and Aylett (2008) demonstrate in the context of urban climate policies. If what is depends on such relations, consequently what happens, i.e. action, is relational, too. ANT does not locate agency in individual actors but conceptualises it as dispersed within actor-networks consisting of human actors and non-human actants, i.e. objects, animals, plants etc. This relational nature of agency clarifies how objects can have agency, too: by being part of an actor-network through which agency circulates (Latour 2005).

For this PhD, this relational sensibility does not only practically clarify the nature of objects such as mathematical models, but it helps to navigate a more fundamental research problem. ANT's relational ontology allows for locating agency without aligning oneself with extreme stances of overemphasizing individuals' autonomy on the one hand or attributing acts to invisible and ubiquitous structures on the other hand. Thus, ANT provides a way to – on the level of social science research – tackle the issue of diffused responsibility for complex risks in reflexive modernity; a state termed 'organised irresponsibility' by Beck (1998, 14) who warns that e.g. in the context of climate change "[s]ociety becomes a laboratory, but there is no one responsible for its outcomes." Taking relational ontology seriously as a researcher then implies forensic work of tracing ties and following the research object – climate risk – on its translation journey through actor-networks. Instead of providing theoretically pre-defined hypotheses on dynamics for such work, ANT demands radical empiricism centring data and asking the researcher to take accounts from the field seriously rather than imposing social theory vocabulary and concepts onto them (Barry 2013, 417–18; Latour 1999; 2005, part I; Law 2008). The

impossible struggle to adhere to this ideal, to always trace all ties and relations within the boundaries of a single PhD project constitutes a common thread throughout this thesis and partially motivates the development of a wider and inclusive research agenda on climate risk at its end to trace the legions of ties not followed in this PhD.

The third sensibility – to the uncertainty of practice – highlights the precarious nature of social ties which need to be stabilised with immutable objects to allow for complex societies to function without having to rely on impractical direct social interaction. In the context of knowledge construction, this sensibility points to the constant probing and testing of links and relations which Callon (1986, 207) and Latour (1987, chapter 2) refer to as “trials of strength”. This sensibility implies two things: First, for the researcher it creates the imperative of “staying with the trouble” (Law and Singleton 2013, 488). If relationships are indeed precarious, they can never be taken for granted and the work of stabilising and defending them or of probing and disrupting them is constant and needs to be identified and traced. This in turn leads to the second implication: alternative realities are always at the researcher’s fingertips. If ANT is a methodology to trace the steps and moments of how precarious relational ontology is performed, stabilised, or dismembered, it also becomes a methodology to identify alternative realities, to locate where, how, and when a certain tie failed and a different one succeeded as Blok (2010) shows in his account of the changing nature of carbon in carbon markets. It becomes a vehicle to research ontological politics defining what the world around us is (Law and Singleton 2013; Mol 1999).

To sum up, ANT for this thesis is a methodology to see and trace ontological techno-politics. By accounting for non-human agency and by locating dispersed but networked agency, ANT allows to trace who and what defines climate risk, who and what thus governs the finance-climate-nexus. By identifying the precarious origins of ties and by tracing their micro-level stabilisation, ANT provincializes rather than naturalises knowledge construction in and around the TCFD and thus helps to point towards alternative worlds.

Of course, bringing ANT, a framework developed for science laboratories and engineering workshops (Muniesa 2015), into the realm of governing the finance-climate nexus is neither simple nor unproblematic. It is not simple since – as mentioned above – ANT’s radical empiricism demands an adaptation of ANT to the empirical case at hand (Barry 2013, 417–18): “Theory and data are created together” (Law 2008, 629). Furthermore, the secretive nature of technocratic financial governance in particular and of international politics and governance in general poses multiple access issues discussed in more detail in the section on data collection and analysis (Barry 2013, 426–27). It is problematic as well in the sense that in international politics dynamics and forces become pronounced which are not as relevant in science laboratories and thus underappreciated by ANT. Translation

processes in diplomacy might rely more on intangible factors such as a certain conduct or atmosphere rather than material objects (Barry 2013, 424–25). This issue is addressed in the first paper of this thesis. Perhaps more fundamental, ANT might lack the conceptual toolkit to account for the imprints of historical contexts and path dependencies or to identify what is often subsumed under the term structural power (Barry 2012; 2013; Koddenbrock 2014; Lave 2015; Mills 2018; Roberts 2011). This thesis speaks to these concerns, first, by demonstrating how history and structure can be accounting for within ANT, second, by making explicit ANT’s limits in doing so, and third, by proposing a solution to the practical limitations of ANT in that regard by formulating a wide and inclusive research agenda in the spirit of but not limited to ANT in the fourth paper of this thesis.

1.4.3. Risk

The choice to focus on the construction of knowledge in and through the TCFD preceded the choice to trace the construction of climate risk as central knowledge object. Thus, the chronology of this PhD explains but does not justify the decision against a more risk-focused theoretical framework. This subsection therefore seeks to make explicit how alternative theoretical orientations conceptually foregrounding risk relate to the ANT perspective chosen.

Since social science literature on risk is legion, this brief survey cannot fully do it justice. It rather focuses on three strands of the literature particularly relevant to the role and nature of risk in the context of the TCFD: riskwork as organisational construction of risk, risk calculation within the social studies of finance as finance-specific mode of risk construction, and the regulation of risk as institutional setting in which the TCFD is conceived.

Riskwork is not so much a theory but a conceptual framework that brings practice-centred sociology to bear on the organisational construction and management of risk. In doing so, it shares large parts of its foundations with practice-oriented STS (Power 2016a): practice is conceptualised as situated and situational calling for an ethnomethodological approach; material artefacts mediate and thus partake in practice; intentionality is not exclusively located in the individual but is constituted by “interlocking intentionalities” (Power 2016a, 7). Thus, riskwork and ANT resemble each other tremendously in their conceptual foundations. In its application, however, riskwork is predominantly employed to unpack how certain types of risks are assessed, measured, gauged, materialised, and managed in specific organisational contexts (Power 2016c). Thus, while riskwork appears to be ideally suited to investigate current practices of climate risk management and assessment in e.g. financial institutions, it does not have a track record or particular conceptual provisions to inquire early phases of risk construction in which the contested issue is not the exact measurement or interpretation of climate risk but its basic ontological status of existence, i.e. whether climate risk is real for finance. While riskwork might have therefore neglected parts of the construction of climate risk covered in the first paper of this PhD, it

could have sharpened the focus of the subsequent papers on aspects and dynamics of auditability. For instance, a riskwork approach would have guided the research towards questions of how the production of artefacts – e.g. standardised climate scenarios – or a focus on the governance and processes of risk management rather than on its substance in the TCFD recommendations relates to the ideas and pathologies of an audit society (Power 2016b).

While perhaps theoretically more diverse than riskwork, studies on risk within the social studies of finance (SSF) tend to converge on foregrounding the constitutive and productive role of calculative devices. The Black-Scholes model, for instance, has been found to shape rather than merely predict option prices and to facilitate explosive growth in option markets by isolating a particular type of risk that had previously remained unmeasured (MacKenzie 2006; MacKenzie and Millo 2003; Smith 2012). Such device-based quantification of risk can be instrumental in giving rise to entirely new risk cultures (Mikes 2011), e.g. encouraging risk taking behaviour (Besedovsky 2018), and can lead to moments of resonance amplifying financial market dynamics where overconfidence and widespread use of such devices come together (Beunza and Stark 2012a; 2012b). This literature instructs the third and constitutes a key pillar of the fourth paper in this thesis. If it had been brought into this PhD at an earlier stage, it might have focused the research on calculative devices such as carbon intensity metrics discussed within the TCFD. It might have even steered the entire research focus towards market-based calculative practice during the implementation of the TCFD recommendations rather than the qualculation (Callon and Law 2005) in governance tool designs preceding and delineating calculation in markets. In that sense, SSF literature on risk is not considered an alternative to an ANT approach – especially given how deeply rooted many SSF concepts are in ANT – but rather as an extension relevant to some parts of what this PhD is interested in and highly relevant to where research on climate risk could be taken next.

The breadth and depth of literature on the regulation of risk mirrors the explosion of risk-based regulation itself. Rothstein, Huber, and Gaskell (2006) conceptualise this trend as a dynamic of risk colonization in which the regulation of societal risk creates institutional risks for the regulator in turn affecting the ways in which societal risks are regulated. The prioritisation and regulation of risks is therefore not neutral but moulded by its political and organisational environment (Baldwin and Black 2016). The reflexive nature of risk regulation and management has been emphasized in this context by many scholars (e.g. Power 2007). The perhaps most prominent example is the theory of risk society. Risk society emphasizes this reflexive nature of societies awakening to the fact that their risk management creates new risks while simultaneously lacking the institutions to respond to this fact leading to a state of organised irresponsibility (Beck 1998; 2009; 2010). Risk society is therefore not a conceptual approach to understand knowledge production or the micro-politics of risk construction.

Hence, it is not immediately applicable to the task this PhD has set out to solve, i.e. to investigate how a specific type of risk – climate risk – is constructed as knowledge object in a particular context, namely the governance of the finance-climate nexus. However, it can serve as a macro-lens through which to motivate the research and interpret the findings of this PhD since the main questions of concern for Beck (Beck 1998; 2016; Curran 2015) are being (partially) addressed in all papers. Who gets to define what (climate) risk is? How is it distributed? Who decides which hazards get managed and which do not? The general insight on the reflexive nature of risk and the potential dynamic of risk regulation creating new risks might have focused the attention of this PhD research more on how e.g. reputational risks for regulators shaped the selection and definition of climate risk(s). Given that such dynamics did not go undetected in this PhD and indeed occur throughout all three empirical papers, the ANT approach seems to de-emphasize rather than neglect this key lesson from the literature on the regulation of risk.

1.5. Data collection & analysis

1.5.1. Research questions, research plan, and Covid-19

While the questions posed by Beck's risk society are partially being answered by this thesis, the main research question remained how finance governs and organises its relationship with the planet's climate. Given the case selection discussed above, this main question was specified and split into three sub-questions segmenting the research object into phases: an origin, development, and implementation phase. Over the course of the data collection, these sub-questions morphed into questions moving climate risk rather than the TCFD as such into the focus of inquiry as mentioned above (see figure 1).

Phase	Initial research question	Eventual research question
Origin	How did the TCFD come into existence?	How did climate risk become a fact sufficiently convincing to create the TCFD?
Development	How did the TCFD develop its recommendations?	How did the TCFD construct climate risk through its recommendations?
Implementation	How are the TCFD recommendations implemented?	How are climate futures imagined?

Table 1: research questions

The original research plan envisioned to collect data on the origin and development phases first while starting to prepare field access for ethnographic fieldwork on the implementation phase which could still be studied *in vivo*. However, worldwide lockdown measures in reaction to the Covid-19 pandemic starting in March 2020 made it necessary to adapt this original research plan. In short, in-person observations became impossible and negotiating online field access became difficult since targeted organizations were occupied with adapting to the pandemic, staff working on climate risk became increasingly sought after due to new regulatory requirements, and the absence of in-person meetings

and conversations impeded the building of trust with gatekeepers. Given these changed circumstances, attempts were made to conduct in-depth case studies of how the TCFD recommendations were being implemented through online interviews. While 18 interviews were conducted as part of these attempts, the data thus collected did not meet the level of granularity required for an ANT-based study. Hence, this 'plan B' was abandoned in January 2021.

Circling back to the literature surveyed above and the main question driving this PhD, an alternative study design to answer the third sub-question was developed. Instead of focusing on the implementation of the TCFD recommendations within individual organisations, i.e. focusing on those being governed, attention was shifted back to those who govern: central banks. The NGFS, which by early 2021 had grown significantly in size and significance for the finance-climate nexus since December 2017, had started to develop a new governance tool which both directly aided their own governance priorities and was simultaneously suitable to implement a central TCFD recommendation, namely the conduct of climate scenario analysis. This new tool was a set of climate reference scenarios (NGFS 2020; 2021a). During the interviews conducted for 'plan B', scenario analysis had come up repeatedly as most challenging and as critical element of implementing the TCFD recommendations while the NGFS scenarios had been highlighted as pivotal reference point for financial institutions, particularly those based in Europe. Thus, the third sub-question was reformulated to focus not on the TCFD recommendations as a whole and their organisationally contingent implementation but to zoom in on what is widely considered the most novel and crucial part of the recommendations: the forward-looking engagement with climate futures. Hence, the third paper in this PhD traces the development of the NGFS climate scenarios as critical governance tool with global reach (NGFS 2021b) to answer the question of how finance imagines its climate futures. While thus somewhat bending the neat original design of following the TCFD creation, the development of its recommendations, and then their implementation, this final design remains anchored in the original research question and the focus on the knowledge dimension of governance. It is motivated both by an academic literature pointing to the crucial role of calculative devices in ordering practice within finance and it is responsive to a quickly evolving governance landscape.

With ethnographic field work thus being prevented by the pandemic, this PhD research ended up heavily relying on interview data supplemented and complemented by document data and observational data from conferences, workshops, and other events. The following sub-sections will broadly discuss how these modes of data collection were employed, how they respectively helped in addressing the research question, and what biases and limitations remain. Subsequently, data analysis will be discussed.

1.5.2. Data collection

1.5.2.1. *Semi-structure interviews*

Traditionally, ANT studies had been based on an ethnographic immersion into the field. By now, interviews have been established as viable and common means of data collection for conceptual frameworks with a relational and material ontology as well, however (Fox and Alldred 2014). Given that this PhD is tracing processes in the past rendering direct observation impossible, interviews remain as primary means to know what cannot be observed (Patton 2002, chapter 7). Alternatives such as written documentation or recordings were not or only very partially available. This lack of accessible documentation has different reasons. For instance, while in the early stages of what would eventually lead to the creation of the TCFD informal interactions which simply did not get documented played a critical role, later stages of e.g. the TCFD internal discussions around the recommendations were indeed documented but the secretive nature of transnational financial governance and the FSB makes it impossible to access those documents as a third party.

A semi-structured format rather than a fully structured or completely unstructured one was chosen for several reasons. First, the purpose of conducting interviews both with elites and with 'experts' is to gain access to knowledge the interviewee has privileged access to (Littig 2009). Thus, per definition the interviewer will not be aware of everything relevant the interviewee has to contribute to the interviewer's understanding of the research object. Some flexibility in the interview to allow the interviewee to bring up these 'unknown unknowns' is therefore necessary. Second, the opacity of the research object often makes it difficult to fully gauge in advance what exact role any given interviewee had in e.g. the set-up of the TCFD or the development of the TCFD recommendations. Some interviewees with official roles suggesting a deep involvement in certain aspects of the research object turned out to not have been as involved as expected. Conversely, one NGO representative, for instance, approached for an interview on the implementation of the TCFD recommendations disclosed during the interview to have briefed TCFD members during the development process. In such situations, the flexibility of a semi-structured interview was crucial to spontaneously adapt interview questions and take advantage of the specific perspective the respective interviewee could offer.

Some structure during interviews was still necessary for two reasons. First, to keep the conversations focused on the research questions and the knowledge dimension of the governance work under investigation. Especially when interviewing elites which often actively attempt to steer the conversation into directions of interest or relevance to them, pre-defined thematic blocs and questions are essential to generate data of sufficient depth and granularity. Second, pre-defined themes and questions covered across interviews can both ensure a certain degree of data reliability by allowing for triangulation and are a means to detect contradictions that are not simply due to faulty memories but

can be indicative of divergences of interviewees' agendas or perceptions. Thus, the semi-structured interview format was chosen for all interviews conducted for this PhD research.

The recruitment of interviewees for the first two phases – origin and development – proved unsurprisingly challenging given the target group of financial and regulatory elites and the somewhat inaccessible space of global governance institutions (Barry 2013; Littig 2009). Five strategies for interviewee recruitment were employed in parallel with varying degrees of success. First, potential interviewees whose email addresses were publicly available were sent an email introducing the research project and requesting an interview. Given that those individuals were approached since they had official roles within or around the TCFD and were thus either very senior or highly sought after, this strategy had a low success rate. Second, a senior colleague at LSE was able to make several introductions to individuals involved in the TCFD. These introductions all led to interviews. Third, a snowball strategy was employed where interviewees would suggest and sometimes write introductory emails to other interviewees. This recruitment strategy was critical not just to gain access to elite interviewees in general but also to trace the parts of the actor-network not visible from the outside. This was particularly relevant for tracing the origin phase in which the role of many central actors had not been made public while the frontstage of international diplomacy required to foreground the role of other actors who were effectively irrelevant to the process of constructing climate risk and setting up the TCFD. Fourth, conferences, workshops, and other events were visited to recruit interviewees both identified beforehand such as specific TCFD members giving speeches at a certain conference and identified during conversations at said events. This recruitment strategy was primarily targeting participants for the implementation phase but also helped to get access to interviewees relevant for the origin and the development phase. Lastly, a handful of interviewees could be recruited via contact requests on LinkedIn. This strategy proved surprisingly effective in accessing elites particularly once the pandemic made it impossible to make contact at in-person conferences. All interviewees gave written consent after having been presented with one of three interviewee-specific consent forms (see appendix A).

In total, these recruitment strategies led to 93 interviews of which five ended up being discarded from the dataset as they contained no relevant information for the eventual focus of this PhD. Interviews lasted on average 56 minutes and ranged from 20 to 140 minutes. Of course, not every interview minute carries the same amount, quality, or relevance of information, however. While 88 interviews fed into this PhD, the empirical papers heavily rely on roughly 25 interviews each with some overlap between the papers on the origin and the development phase. Thus, the vast majority of interview data underpinning the core arguments of this PhD is derived from around 70 interviews. Far from superfluous, however, the other interviews remain formative for this PhD as they helped to

contextualise the focus topic of each paper, aided a general immersion into the field, triggered questions leading to issue areas and interviewees that then became fundamental for this research or simply allowed to access other relevant interviewees.

How interviews were conducted changed over the course of the three and a half years of data collection from March 2018 to September 2021. The most obvious and sudden change in spring 2020 was the shift from conducting interviews predominantly in person in the UK, France, and Germany to online and telephone interviewing. While such a shift could have resulted in e.g. lower levels of attention on the part of interviewees (see Holbrook, Green, and Krosnick 2003), the general experience especially towards the beginning of the pandemic was that interviewees tended to have more time and shared more of their personal life and experience of the pandemic at the beginning of interviews partially facilitated by the fact that – for them – the interview took place in their own home. This often generated a relaxed and more talkative atmosphere during interviews. In general, with the pandemic turning the field into the online space of computer screens and home offices, the interview simultaneously remained located in the field (Howlett 2021).

Changes to the conduct of interviews not externally enforced but consciously made involved a more pronounced individualisation of interviews and the use of visual and textual devices during interviews. The former was gradually implemented starting about halfway into the data collection for the origin and the development phase. The motivation was to increase the depth of data by pursuing topics that have come up as relevant or particularly controversial in previous interviews and the respective interviewee had had significant involvement in or knowledge on. This implied a prioritisation of follow-up and probing questions over pre-defined questions on additional topics during the interview and shifting from a systematizing to an exploratory interview style (Bogner and Menz 2009).

The latter change to the conduct of interviews – the use of devices – was meant to fulfil the function of enhancing data reliability despite a decrease in topic-related overlaps between interviews due to an increase in individualisation. Three figures summarising key findings on the origin and the development phase (see Appendix B) were printed out or shared virtually with interviewees from June 2019 onwards and instead of asking general questions on how these two phases unfolded in their eyes, interview partners were asked whether they found the figures to be broadly correct or whether they had anything to add or to change about them. The use of these figures as method of member checking did not only create greater confidence into the reliability of the data collected (Nowell et al. 2017). It also ended up increasing data granularity as interviewees felt prompted to pick out and elaborate on elements of the figures they considered particularly relevant. While full-fledged member checking proved impossible given the time constraints of interviewees, this partial member checking

complements triangulation as important means to ensure credibility of this research (Nowell et al. 2017, 3).

1.5.2.2. *Documents*

Documents as objects can be what ANT calls “immutable mobiles” (Latour 1987, chapter 6) and thus be powerful actants stabilising relations. Constitutive of modern life, they can facilitate control and coordination and therefore nearly always need to be taken into account as relevant source of data (Freeman and Maybin 2011). While especially in financial markets documents can be a revealing window into the construction of authority (see e.g. Simons 2016) or into strategies of obfuscations and distraction (see e.g. Tischer, Maurer, and Leaver 2019), documents in the context of the TCFD and climate risk knowledge and governance differ in important ways. First, where documents are routinely produced in financial markets conduct, many key events and interactions especially during the origin phase were informal and not documented or of the kind that is meant to produce documents as outcomes. Second, while distinct financial market practice is often expressed or recorded in standardised document formats such as product specifications or Bloomberg Terminal chat histories making the identification and sampling of documents comparatively easier, the documents relevant to the research questions of this PhD range from handwritten notes of key actors to presentation slides, diplomatic letters, and meeting minutes. Third, where relevant documents were produced and held in a centralised space – i.e. within the TCFD Secretariat – the documents were inaccessible. Together, these factors make a general document sampling and gathering strategy for this PhD research impossible.

Given the above, this PhD does not employ a full-fledged document analysis in the strict sense (see Tight 2019) but treats documents – in the spirit of ANT – just like human actors in the field. Chance encounters with different documents aided a general immersion into and familiarity with the field just like chance encounters with conference or workshop participants did. Most importantly, however, documents were made part of the data where they were either of immediate and obvious relevance – i.e. the three final document outputs of the TCFD and the NGFS publications around their climate scenarios – or where they were flagged as relevant by interviewees. Thus, document sampling was conducted similarly to interviewee sampling targeting both officially associated individuals/documents and then expanding the sample via snowballing. A major difference between documents and interviews as data sources is, however, that documents often serve multiple purposes whereas interviews could target questions and issues of relevance to this PhD research which often renders large parts of documents irrelevant rendering coding of these parts meaningless (Gross 2018). For instance, publicly available documents on the FSB’s work and mandates would comprise multiple

pages covering topics from cyber-security to shadow banking with only few sentences addressing the TCFD or climate change.

Thus, documents in this study fulfil a dual auxiliary role rather than being a data collection strategy in its own right. First, documents instructed the design of interview guides where aspects of the documents – or omissions in the documents – raised questions. For instance, the openness of the G20 mandate instructing the FSB to engage with the issue of climate change gave rise to the question how and why this mandate was carried out by focusing on the creation of a disclosure framework. Second, documents allowed for some degree of triangulation. For instance, a birthday letter from Mark Carney, erstwhile Governor of the Bank of England, to HRH The Prince of Wales confirms in principle if not in detail the relevance the latter played in convincing Mark Carney to become active on climate-related financial issues (see Carney 2018).

1.5.2.3. *Observation*

Observation was conducted at conferences, workshops, and – since the beginning of the pandemic – webinars which were partially or in whole dedicated to aspects of the TCFD and/or climate scenario analysis. Comprehensive lists of the events observed can be found in the appendixes of the paper on the origin phase and on the NGFS climate scenarios as observational data turned out to be most relevant for these two papers. Sampling of events was guided by considerations on proximity to the core processes of interest to this PhD. This meant that for an event to be considered relevant, at least one speaker or panellist had to be directly involved in the origin phase, the development phase, or the design of the NGFS climate scenarios. Sampling was further restricted by the costs of attendance leading to a bias favouring publicly organised conferences which – however constitute the vast majority of large-scale and relevant conferences on climate risk. Prior to the pandemic, location restricted participation as well. While originally a stay in the US over several months was supposed to extend the sample from purely European to North American events, the pandemic prevented this strategy from being implemented. However, the shift to online conferences and events in reaction to lockdowns and travel restrictions somewhat alleviated the geographical bias.

Although the observation conducted does not amount to actual direct observation of the research object, i.e. of the construction of climate risk knowledge through the TCFD or the NGFS climate scenarios, it enriched the data collection in several ways. First, observation facilitated access to parts of the field that would have otherwise been left uncovered in two ways. On the one hand participation at conferences and events provided the opportunity to engage with relevant individuals in person, introduce the research and request an interview. On the other hand, individuals which were not available for interviews could still be observed and their accounts could be integrated into this study where they either participated in panel events, gave speeches, or were willing to have brief informal

conversations on the side lines of the event. Thus, observation became a tool to mitigate against the bias inherent in interview-based data collection strategies against senior individuals who often do not have or make the time for research interviews.

Second, frequent participant observation at conferences and workshops ensured an increasing degree of familiarity with the finance-climate nexus. This familiarity with e.g. a sensitivity to what topics were particularly controversial or consensual in turn instructed the design of interview guides. Also, it very likely affected the conduct of interviews in subtle ways as often in 'expert' or elite interviews the capacity of the interviewer to demonstrate a certain degree of 'expertise' can make interviewees more eager to share their perspective and knowledge (Littig 2009).

Third, observation allowed for the accumulated collection of a different type of data, namely data on the general atmosphere or discourse of the field highlighted as important by Barry (2013). Given that neither atmosphere nor discourse are analytical categories anchored in ANT, it is important to specify how exactly such data – or how such a sensibility – was used in the context of this PhD research. Such data allowed to prioritise or dismiss certain lines of inquiry that operate on a discursive level. For instance, the phenomenon of cultural or cognitive capture among central bankers has often been found to explain aspects of their actions (Kwak 2014; Özgöde 2021). Thus, several design features of the NGFS scenarios – e.g. the focus on growth-oriented economic models – could have been explained by a siloed and captured nature of central bankers' thinking. Participation at multiple conferences and workshops where central bankers were confronted with or pro-actively engaged with alternative discourses, e.g. around de-growth, however, helped to seek explanations elsewhere.

Fourth, observation widened the scope of voices heard in this PhD. While by no means exhaustive, the diversity of participants at workshops and conferences complemented the rather narrow range of voices captured in interviews – voices which were closely involved in the successful construction of climate risk knowledge rather than those involved in unsuccessful attempts. Thus, capturing alternative and sometimes dissenting voices during observation sharpened the sensitivity to alternative framings and understandings which could then be probed during interviews.

Lastly, observation data also allowed for opportunities to triangulate. For instance, the anecdote of the Prince of Wales prompting Mark Carney to engage with climate-related issues at the Bank of England was corroborated by a speaker at a conference who attended the relevant meeting between the Prince and Governor Carney.

1.5.2.4. *Biases and limitations*

Despite the broad data basis and the attempt to diversify data collection to allow for triangulation, the mode of data collection described above suffers from several shortcomings. Perhaps most relevant in

the context of an ANT-based study is the potential blindness to the significance of materiality. The lack of direct observation of practice in the origin phase, the development phase, and the NGFS scenario design phase could lead to an underappreciation of the role of non-human actors. In an attempt to mitigate against this potential bias, interviewees directly involved in the TCFD's origin or development phase were explicitly asked about relevant objects with this or a variation of the following question: "My research approach focuses – among other things – on the role of non-human elements or objects such as graphs, tools/instruments, reports or frameworks and concepts, labels etc. In your work, what objects were important for developing the recommendations?" To further support and facilitate the question, additional examples relevant to the interviewee as well as the TCFD report as such which was physically brought to all in-person interviews were produced. However, interviewees sometimes still struggled to fully grasp the question and typically focused on reports or briefing papers in their answers rather than understanding objects in a wider sense. In general, responses fell into one of two buckets: Either interviewees ended up assigning equal relevance to a range of several dozen objects, typically reports, briefing papers, and presentations, or they stated that no objects were particularly decisive. In some exceptional cases, interviewees would highlight specific reports which they personally had a connection with either as author or as funder. Given that these cases were never corroborated by other interviewees, they were dismissed.

More targeted questions were asked on the design of the NGFS climate scenarios since certain objects – a wide range of mathematical models and databases – were obviously relevant from the very beginning of data collection. These targeted questions led to rich accounts of the role of these particular objects. Interviewees – particularly natural scientists – typically brought up objects during interviews without explicitly labelling them as such. This somewhat increases confidence that during the TCFD's origin and development phase objects were indeed not as central to the respective actor-networks as ANT might expect. While this finding resonates with accounts of the relevance of human interactions both in finance (MacKenzie 2004) and in transnational governance (Barry 2013), it cannot be conclusively rejected that it might also partially be an artifact of the interview method and the specific interview instrument posing general rather than specific questions about the role of objects.

A different pitfall during interviewing is the potential omission of interviewees engaging in storytelling rather than in genuine accounts of events or experiences (Rubin and Rubin 2012, 28–29). While relevant to the entire data collection process, this issue might be particularly prevalent when interviewing elites skilled in rhetorically pursuing specific agendas as in the case of the TCFD development phase. Three strategies were employed to better identify such moments of storytelling by interviewees. First, triangulation using other interview data or – where possible – document and observation data was pursued. Given the sometimes extremely low number of individuals present at

certain relevant events as well as the limited time with each individual interviewee, possibilities to triangulate were often limited to one other data source. Data which could not be triangulated was exclusively used to challenge and never to support any arguments presented in this thesis. Second, during data analysis indicators for storytelling were scanned for to caveat passages of interviews. For instance, storytelling by interviewees in this study was often characterised by the use of catchphrases, metaphors, historical comparisons, and other narrative and stylistic devices. In one instance, an interviewee was observed using the exact same formulations at a conference that they used a few weeks before during an interview to describe a particular event pointing to the rehearsed and habitual nature of some storytelling. In cases where storytelling was detected, the data analysis mode was switched from semantic to latent (Braun and Clarke 2006, 84–85) and from empathetic to suspicious interpretation (Willig 2014).

A final bias pertains to the sampling of interviewees. The sampling strategy of tracing the respective actor-networks ‘inside-out’, i.e. starting with interviewees who are clearly central nodes in the network, inevitably leads to a certain prioritisation of the core over the periphery, i.e. of incumbents who obtained central positions in the network over unsuccessful challengers. While interviewees were actively sought out who were not directly involved in the TCFD’s origin and development phase, these interviewees were still approached on the basis of their professional involvement in climate-related accounting or disclosure. This poses the question to what degree the knowledge, views, and interests captured in those interviews constitute a substantial and not simply a marginal deviance from those in the heart of the actor-network. In other words, the interviewee recruitment strategy of focusing on professional specialists – whether working in the for-profit, the public, or the not-for-profit sector – might have limited the cognitive frames, views, and interests captured in this study therefore potentially narrowing the breadth of probing questions that were posed to interviewees at the centre of the actor-network.

1.5.3. Data analysis

1.5.3.1. Approach

While ANT-based analysis is predominantly interested in a rich description of the data avoiding the imposition of theoretical language or concepts prematurely narrowing down or streamlining the complexity of the research object, it still operates with a distinct vocabulary and conceptual tool kit. Hence, the data analysis process for this PhD needed to be flexible enough to allow for both a data-focused inductive approach and for an introduction of ANT concepts at a later stage. Thematic analysis offers this flexibility and was therefore chosen as general framework for data analysis (Braun and Clarke 2006; Nowell et al. 2017). Given the flexibility possible within thematic analysis, this section spells out in more detail what strategy for thematic analysis was chosen for this PhD.

First, consistent with ANT, thematic analysis was employed to provide a rich description of the whole of each respective dataset – i.e. the data set on the NGFS climate scenarios and the data set on the TCFD – rather than focusing on specific areas within each set. This approach, however, was departed from in the case of the TCFD later in the analysis process as the papers on the origin phase and the development phase of the TCFD obviously only capture their respective focus areas of the data set. Thus, for the phase of bringing individual codes into conversation with one another to develop themes, the TCFD specific data set was separated into coded data relevant for the origin phase and relevant for the development phase. This allowed for a more in-depth exploration of these respective areas within the data while maintaining coding consistency as well as a still holistic perspective on the richness of the entire TCFD data set.

Second, coding was conducted inductively to follow ANT's tenet of taking empirics seriously. Coding never takes place in a theoretical vacuum, however (Braun and Clarke 2006, 83–84). Thus, to stick as closely to the data as possible and avoid a premature introduction of theoretical structure into the processes of coding and identifying themes, doubt was constantly nurtured as productive force throughout the analysis process (Locke, Golden-Biddle, and Feldman 2008). In practice, this manifested in an effort to pursue lines of inquiries towards the new and the unknown, doubting explanations familiar to the researcher.

Third, taking actors in the field and their particular perspective on and within the actor-network seriously implies that a semantic or topical rather than a latent or cultural focus was taking during data analysis (Braun and Clarke 2006, 84–85; Rubin and Rubin 2012, chapter 3). Thus, during coding the content of what was being said was foregrounded rather than a suspicious interpretation (see Willig 2014) of what the ideational foundations behind any statement might be. While ANT is not treated in an orthodox manner in this PhD, an attempt was thus made to deviate as little from a description of the empirics, i.e. the data, and seek explanations not outside of the data, whether that outside was theory or an interpretation of data (see Latour 2005, 136–40).

1.5.3.2. *Process*

The three basic tenets summarised above guided the analysis process which unfolded in the following common steps (Braun and Clarke 2006; Green et al. 2007): In an initial phase data immersion was pursued by bringing data into textual form. For interviews, this meant either the cleaning up of transcripts generated by a voice recognition software or by a third-party transcription software or the entire transcription of interviews where they were conducted in German, the author's mother tongue. In the case of observational data handwritten notes were typed up. Documents and notes which were already typed up because they were taken at an online event were simply read. From this initial phase of data immersion, a set of codes was generated which was successively expanded and edited during

coding. For both the TCFD and the NGFS data set two rounds of coding were conducted using the software NVivo 12 particularly helpful to organise and code the large TCFD specific dataset. The second round of coding exclusively focused on data already coded. This second round and the development of themes were tightly interlinked as often the merging of codes would lead to the development of a theme. The defining, naming, and relating of themes, however, took place after the finalisation of coding and outside of the coding software in the form of simple hand drawn mind maps and diagrams which would – after consolidation – be typed up in the form of bullet point lists. In the case of both the TCFD and the NGFS data set, this process was characterised by a repeated moving in between data collection and data analysis common in qualitative research (see e.g. Green et al. 2007; Lund 2014). However, this back-and-forth movement was more pronounced for the TCFD-specific data analysis due to the relatively long period of data collection (March 2018 to February 2021).

1.5.4. General limitations

Despite its flexibility, thematic analysis is not well suited for an analysis of the linguistic layers of the research object (Braun and Clarke 2006; Nowell et al. 2017). While ANT with its roots in semiotics sensitises to all ways of world-making, including language-based ones, this PhD does not fully unpack this dimension of ontological politics in a way an e.g. discourse analysis would have done. This limitation is perhaps most significant for the second paper of this PhD which covers the development of the TCFD recommendations as the negotiation of formulations, i.e. the linguistic politics, were most pronounced in this particular phase.

Another layer of the research object this PhD does not unpack – neither in its analysis nor in its data collection – is the issue of affect and emotions. As flagged above, data was not explicitly coded regarding emotional connotations or expressions. Also, while ANT might conceptually offer some avenues to explore ‘spaces of affect’, in practice it has not been used in such a way (McCormack 2020; Müller 2015, 36–37). Hence, this limitation is both of methodological and of theoretical nature. While the first paper of this PhD somewhat uncovers dynamics of affect arising from face-to-face interactions, neither the interview instruments nor the ANT framework explicitly zooms in on the emotional dimension of the climate risk translation process.

While these two general limitations – the neglect of language and of affect – of this PhD are of conscious and/or theoretically induced nature, the final limitation is introduced by necessity rather than by choice. Overall, no peer triangulation of codes or themes was conducted across the three empirical papers of this PhD. Three strategies to enhance the validity of the research in the light of this limitation were employed, however. First, member checking was done for the first two papers of this PhD as explained above. Second, the principle of mobilising and nurturing doubt was used during data analysis as mentioned in the previous section (see Locke, Golden-Biddle, and Feldman 2008). Third,

raw data is presented – both in the form of short and long quotes – throughout all three empirical papers as much as possible without inflating the length of the texts beyond readability. This provides the reader with ample opportunity to assess the validity and merit of the analysis and to get an understanding of the nature and richness of the underlying data (Nowell et al. 2017, 11).

1.6. Paper structure

This PhD consists of three distinct yet interconnected empirical pieces on the TCFD's origin phase, its development phase, and on the design of the NGFS climate scenarios. It thus traces the construction and translation of climate risk from a knowledge claim into a fact, from a thought experiment into an increasingly formalised and mathematised governance object. These empirical observations prepare the ground for a final theoretical paper. Co-authored with Daniel Beunza, it weaves together insights from both this PhD and a wider literature in the social studies of finance, economic sociology, and other sociological disciplines, to develop a theoretical basis and a research agenda for a sociology of climate risk.

The first paper traces the origin phase of the TCFD but goes beyond a rich description by engaging with the issue of translating ANT itself. As mentioned in this introduction's theory section, scholarship is lacking on the implications of translating ANT into domains substantially different from the science laboratories and engineering workshops it was developed for. This first paper addresses that gap in the literature using the translation of climate risk culminating in the creation of the TCFD as empirical background. The task force is shown to be both engine and outcome of successfully turning the knowledge claim that climate change poses material financial risk into a fact. By tracing this translation process, the paper makes three contributions to the literature: First, it shows how spatial proximity and face-to-face (F2F) interaction need to be integrated into ANT as they give rise to facilitative and forcing dynamics enabling knowledge translation. Second, it identifies merits and limitations of ANT in analysing power dynamics arguing that ANT is particularly well suited for the interrogation of reformist struggles rather than instances of fundamental opposition. Third, this paper provides a rich empirical account of the emergence of a critical institution governing the relations between finance and the planet's climate.

Picking up where the first paper ends, the second paper traces the process of how the TCFD recommendations were developed. Employing the methodological sensitivities of ANT, the paper identifies key points of contestation in the industry led TCFD process and finds shifting alliances and oppositions drawing conceptions of the representation of industry interests into question. It argues that while the TCFD membership was recruited explicitly to represent 'the market', positions taken by TCFD members cannot be explained by the mere representation of organisational interests of market participants. Interests pertaining to the collective good played a significant role in structuring

contestations and indeed shaping crucial aspects of the TCFD recommendations. These contestations of and effects on the TCFD recommendations do not only provide insights into the ontological politics of climate risk in the context of disclosure frameworks but they also hold broader lessons for a more nuanced understanding and critique of industry-led governance initiatives. While the TCFD recommendations are unlikely to facilitate market-based mitigation of disastrous climate risk, they do not neatly fit the picture of neoliberal governance dominated by the interests of corporate market participants. Individuals as carriers of interests need to be taken seriously.

After the TCFD had recommended and therefore both legitimised and incentivised the conduct of climate scenario analysis within finance, the NGFS set out to facilitate, steer, and standardise finance's engagement with climate futures by creating a set of climate reference scenarios. Bringing together ANT and an emerging literature on imagining futures, this paper traces how central bankers and scientists designed said scenarios. It argues that to translate abstract climate futures into scenarios operational and legitimate within finance, they had to fulfil imperatives of four obligatory passage points (OPP): central banks' reputations, scientists' professional identity, mathematical models' technical specificities, and finance's operational practices. Each OPP introduced particular imperatives into the design process and is connected to other OPPs through relations of reliance while their imperatives partially reinforce and partially conflict with one another. These imperatives exclude certain types of futures from the design process, e.g. scenarios with high levels of financial stress or scenarios including justice considerations, thus shrinking the space of imagined climate futures for finance. By examining these ontological politics of how finance imagines its climate futures, this paper empirically contributes to our understanding of both the dynamics underpinning the envisioning of futures in the Anthropocene and the role of finance in responding to climate change. Theoretically, this study demonstrates how the imagination of futures can be conceptualised as translation thus advancing a nascent multidisciplinary literature on anticipation and imagining futures.

In the light of both the findings and the limitations of these three empirical pieces, the final paper proposes a way forward by developing a research agenda for an inclusive sociology of climate risk. In doing so, it calls for a broader sociological engagement with climate risk, outlining how the Callonian concept of economization (Çalışkan and Callon 2009) can integrate an institutional and a material approach to climate risk. It considers, first, the complex institutional work that went into making climate change legible to financial actors, of which the creation of the TCFD is a crucial case. With the construction of climate risk today primarily taking place in the forums of mathematical modelling and calculation, of which the NGFS scenarios are a critical example, the paper then turns to models. Drawing on the social studies of finance, the paper underscores path dependencies, silo formation, and performativity as key socio-technical dynamics surrounding climate risk modelling in need of

investigation. Finally, we lay out how Callonian economization can integrate an institutional and a material perspective on climate risk, identifying areas of research on the institutional antecedences of model design, the effects of large-scale model deployment, and alternative problematizations of climate change. The paper illustrates and emphasizes the need to mobilize the full spectrum of sociological expertise – from development to political and economic sociology – to understand and critique this phenomenon fundamentally reconfiguring how finance and the planet's climate relate: climate risk.

Thus, positioned at the intersection of the literatures on transnational governance, science and technology studies, and the social studies of finance, this PhD shows how finance governs its relationship with the planet's climate through the construction of climate risk. It foregrounds the ontological politics of this construction process, thus developing a novel and nuanced critique of how existing actor-network constellations limit and shape the lens of climate risk. This critique as well as the central themes of making climate futures and the potentials and limitations of ANT are further unpacked in the following papers and the concluding discussion.

Appendix A

Consent form TCFD and TCFD Secretariat members



THE LONDON SCHOOL
OF ECONOMICS AND
POLITICAL SCIENCE

Matthias Täger, PhD student
Department of Geography and Environment
Houghton Street
London WC2A 2AE
M.C.Tager@lse.ac.uk

PARTICIPANT INFORMATION SHEET & CONSENT FORM

Section A: The Research Project

Title of project: *The Politics of Green Finance*

Abstract: This study seeks to contribute to a better understanding of the emerging institutional structures governing the integration of environmental issues into financial markets. More specifically, it seeks to explore: (a) the emergence of the FSB TCFD; (b) the decision-making process leading to the final recommendations on climate-related financial disclosure; and (c) the mechanisms and actors involved in the diffusion and institutionalisation of the task force's recommendations.

The study is being conducted by Matthias Täger (PhD student) at the Department of Geography and Environment at the London School of Economics and Political Science (LSE). The research is funded by the Economic and Social Research Council (ESRC). If you have any questions or concerns about the study, please feel free to email Matthias Täger: M.C.Tager@lse.ac.uk. If you have any concerns or complaints regarding the conduct of this research, please contact the LSE Research Governance Manager via research.ethics@lse.ac.uk. To request a copy of the data held about you please contact: glpd.info.rights@lse.ac.uk.

Section B: Your Participation in the Research Project

As an individual with knowledge of environmental disclosure, I would like to invite you to take part in this study. *It is your choice whether to participate.*

If you do decide to take part, I will ask you a series of semi-structured questions. These questions will focus on the TCFD and environmental disclosure. *Note, even if you do decide to take part, you are free to withdraw at any point of the study without giving a reason by emailing:* M.C.Tager@lse.ac.uk.

Section C: Use of data

Short quotes from your interview may be used in resulting outputs. However, names and identities of associated investors, investees or clients will not be associated in any way with your answers. For further options regarding anonymisation please see “Section D: Consent” below. The results of the study will be published in academic journals and presented at academic conferences.

I am very happy to provide you with copies of these outputs if requested. Indeed, I would hope that you might find the results interesting, as well as potentially useful.

Section D: Consent

I agree to taking part in the study	YES / NO
I understand that I am free to decline to participate in this research study, or I may withdraw my participation at any point without penalty. My decision whether or not to participate in this research study will have no negative impacts on me either personally or professionally.	YES / NO
I confirm that I have read and understood the information sheet provided for the above study. I have had the opportunity to consider the information and ask any questions I have.	YES / NO
I understand that my interview data will be securely stored for an indefinite amount of time for the purpose described above.	YES / NO
I agree to the interview being audio recorded .	YES / NO
I was assured that the name of my organisation will not be associated in any way with any information disclosed during the interview.	YES / NO
I was assured that my name will not be associated in any way with any information disclosed during the interview.	YES / NO
I agree to my role as a member of the TCFD or TCFD secretariat being associated with information disclosed during the interview	YES/NO

Please retain a copy of this consent form.

Participant name:

Signature: _____

Date _____

Interviewer name: Matthias Täger

Signature: _____

Date _____

Consent form NGFS scenarios



THE LONDON SCHOOL
OF ECONOMICS AND
POLITICAL SCIENCE ■

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Department of Geography and Environment
Houghton Street
London WC2A 2AE
M.C.Tager@lse.ac.uk

PARTICIPANT INFORMATION SHEET & CONSENT FORM

Section A: The Research Project

Title of project: *Translating Climate Risk – a case study of the NGFS reference scenarios.*

Abstract: This study seeks to contribute to a better understanding of how socio-technical arrangements mediate the assessment of climate risk in the financial sector. Focusing on the case of the NGFS reference scenarios, this research traces the processes through with various models, tools, and bodies of expertise were brought together and translated into the final reference scenarios. It hereby aims at answering the question of how organisational, ideational, and technical logics and imperatives affected scenario design choices.

The study is being conducted by Matthias Täger (PhD student) at the Department of Geography and Environment at the London School of Economics and Political Science (LSE). The research is funded by the Economic and Social Research Council (ESRC). If you have any questions or concerns about the study, please feel free to email Matthias Täger: M.C.Tager@lse.ac.uk. If you have any concerns or complaints regarding the conduct of this research, please contact the LSE Research Governance

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I understand that my interview data will be securely stored for an indefinite amount of time for the purpose described above.	YES / NO
I agree to the interview being audio recorded .	YES / NO

I was assured that the name of my organisation will not be associated in any way with any information disclosed during the interview.	YES / NO
I was assured that my name will not be associated in any way with any information disclosed during the interview.	YES / NO

Please retain a copy of this consent form.

Participant name:

Signature: _____ *Date* _____

Interviewer name: Matthias Täger

Signature: _____ *Date* _____

Consent form others



THE LONDON SCHOOL
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POLITICAL SCIENCE

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Section D: Consent

I agree to taking part in the study	YES / NO
I understand that I am free to decline to participate in this research study, or I may withdraw my participation at any point without penalty. My decision	YES / NO

whether or not to participate in this research study will have no negative impacts on me either personally or professionally.	
I confirm that I have read and understood the information sheet provided for the above study. I have had the opportunity to consider the information and ask any questions I have.	YES / NO
I understand that my interview data will be securely stored for an indefinite amount of time for the purpose described above.	YES / NO
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I was assured that my name will not be associated in any way with any information disclosed during the interview.	YES / NO

Please retain a copy of this consent form.

Participant name:

Signature: _____ *Date* _____

Interviewer name: Matthias Täger

Signature: _____ *Date* _____

Appendix B

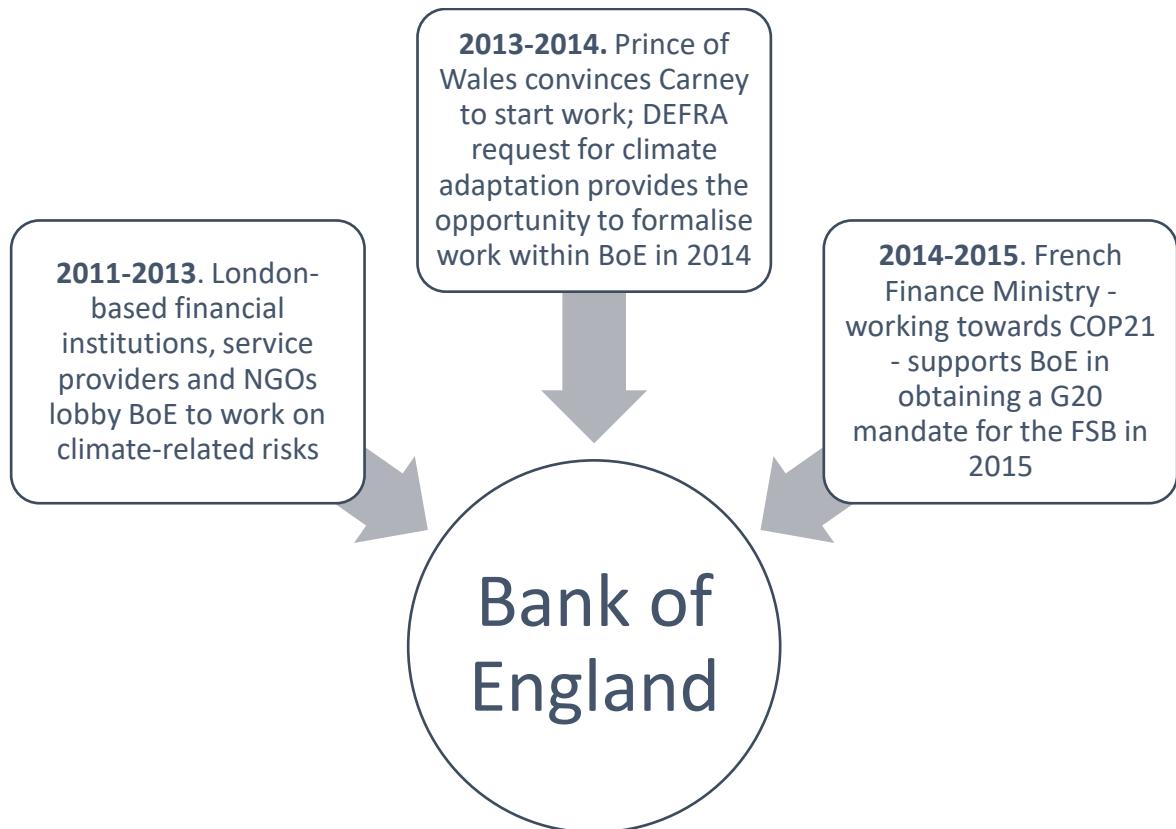


Figure 1: the G20 mandate

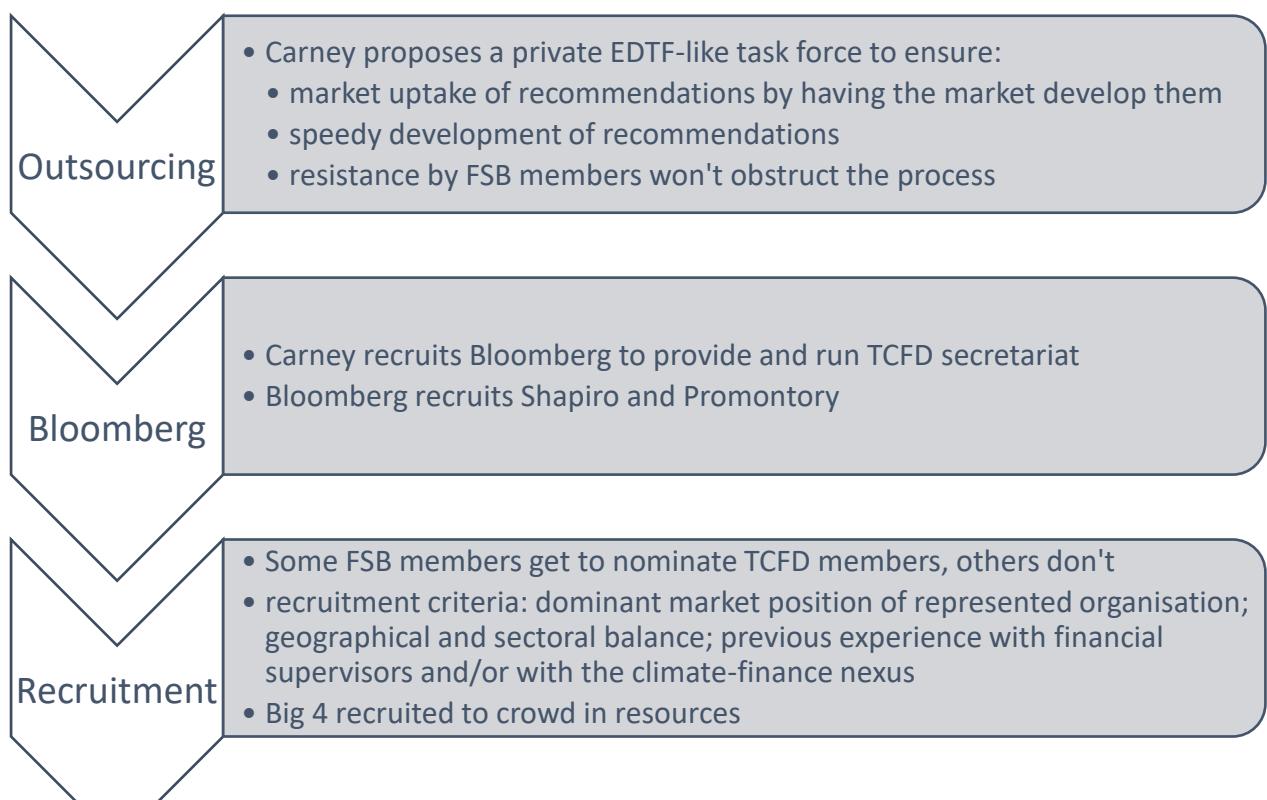


Figure 2: the creation of the TCFD

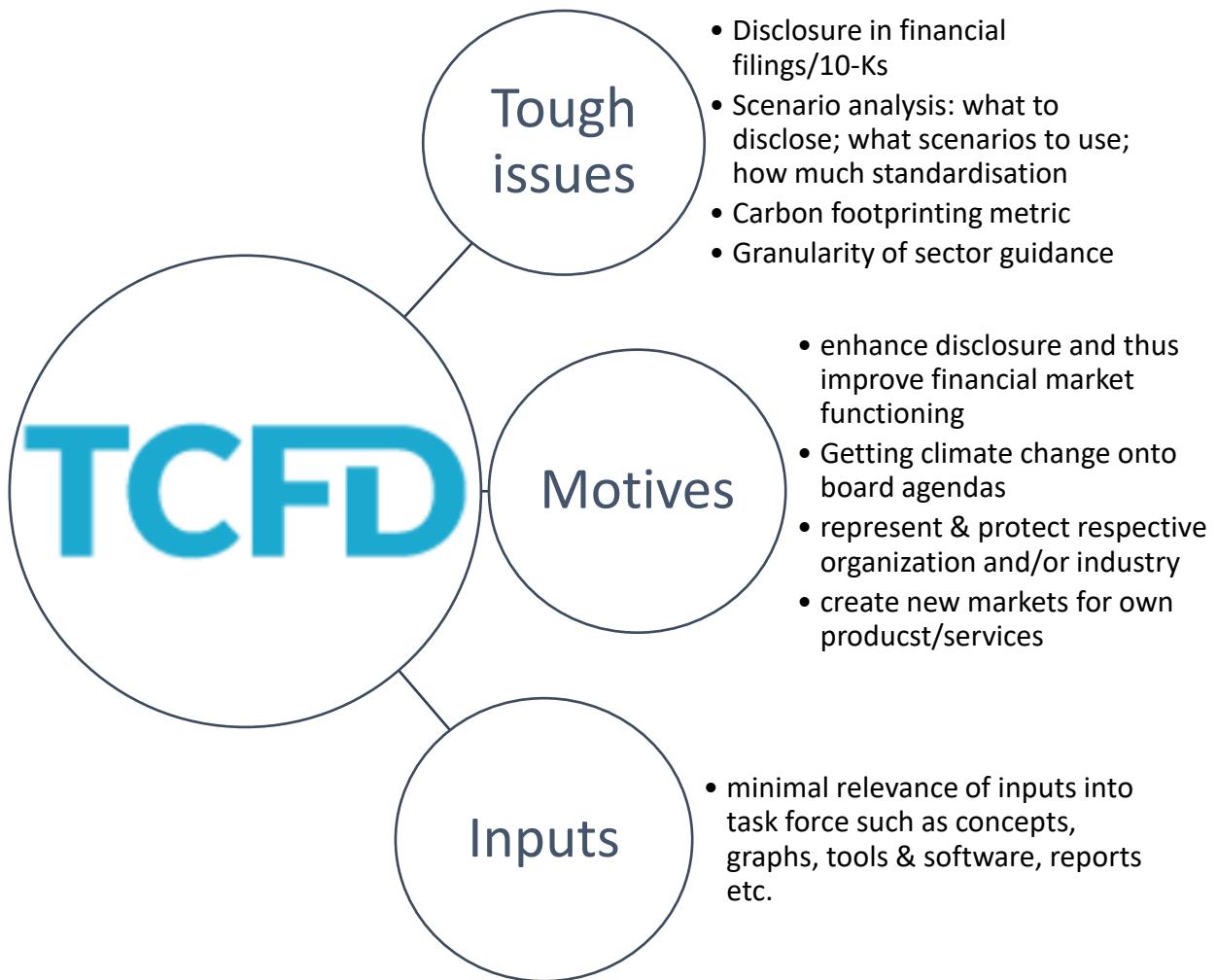


Figure 3: the work of the TCFD

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2. Understanding the making of climate risk using Actor-Network Theory: the case of the TCFD

Abstract

Actor-Network Theory (ANT) is being widely used to understand human-environment relations and their governance. Yet, scholarship is lacking on the implications of translating ANT into domains substantially different from the science laboratories and engineering workshops it was developed for. This paper addresses this gap in the literature using the case of the first public institution to govern the relationship between finance and the planet's climate: the Task Force on Climate-related Financial Disclosures (TCFD). This task force is both engine and outcome of successfully turning the knowledge claim that climate change poses material financial risk into a fact. By tracing this translation process using ANT, the paper makes three contributions to the literature: First, it shows how spatial proximity and face-to-face (F2F) interaction need to be integrated into ANT as they give rise to facilitative and forcing dynamics enabling knowledge translation. Second, it identifies merits and limitations of ANT in analysing power dynamics arguing that ANT is particularly well suited for the interrogation of reformist struggles rather than instances of fundamental opposition. Third, this paper provides a rich empirical account of the emergence of a critical institution governing finance-climate relations.

2.1. Introduction

Actor-Network Theory (ANT) over the past decades has spread into fields and research contexts far beyond the science laboratories and engineering workshops it was originally designed for. The domain of human geography and environmental governance is no exception (Bridge 2021; Müller 2015a) – for good reasons. ANT – originally labelled ‘a sociology of translation’ (Callon 1986) seeks to trace and understand how knowledge claims and technologies are translated in the literal sense of the word, i.e. how they are moved across time and space becoming widely used, regarded as facts or seen as unproblematically working machines. Such technologies and expert knowledge claims have gained in significance for human-environmental relations and environmental governance processes over the past decades (Andresen et al. 2000; Lidskog and Sundqvist 2015; Williams 2012). ANT is well suited to facilitate the interrogation of the construction and the role of said knowledge and expertise in this context (Asdal 2020, 340).

Examples for the usefulness of ANT for inquiries into human-environmental relations and their governance from the local (Collins, Cowell, and Flynn 2009) to the transnational (Acuto 2013) and the international (Bled 2010; Scott et al. 2014) level are legion. Ascui, Haward, and Lovell (2018) demonstrate how ANT helps in understanding the role and agency of models and big data in the context of sub-state environmental governance in Australia. Drawing on ANT’s relational ontology and its attention to materiality Blok (2010) traces different realities of carbon emissions across space. A seminal paper by Rutland and Aylett (2008) on local climate policy making employs ANT to analyse how carbon emissions are being problematised and identities reshaped to facilitate cooperation among political actors.

However, thorough analyses are scarce that reflect on the implications and limitations of translating ANT into research areas different from the laboratories and workshops this theory was developed for. As exceptions to this rule, Barry (2013) identifies theoretical and methodological frictions between ANT and the reality of cross-border governance processes in general while Müller (2015a) theoretically investigates the merits, tensions, and necessary adaptations when employing ANT within economic geography. This paper further advances this work on translating ANT itself. It does so from an empirical rather than a theoretical basis, however. This empirical basis is a case study of the creation of a transnational governance institution straddling the spheres of financial and environmental governance: The Task Force on Climate-related Financial Disclosures (TCFD) set up by the Financial Stability Board (FSB) – the global financial markets watchdog created after the 2008 financial crisis (Mackintosh 2017).

The TCFD was set up to develop guidelines for companies on how to disclose climate-related information (Christophers 2017). By now, these guidelines are set to become mandatory across the

UK, Switzerland, the EU and countless other jurisdictions (TCFD 2021) while also being endorsed by a network of more than 100 central banks and financial supervisors (NGFS 2020). With company disclosures being the raw material from which financial decisions are being formed, governance of this dimension of the finance-climate nexus reaches deep into financial market practice and thus demands scholarly interrogation.

The TCFD lends itself to an ANT-based study since it represents a critical moment of translating a knowledge claim into a fact, the key domain of ANT. This knowledge claim purports that climate change poses financial risks, i.e. climate risks, materialising as e.g. extreme weather events damaging assets, the advancement of climate-friendly technologies disrupting markets, or climate policies imposing costs on carbon-intensive economic activities. This paper shows that the credibility of this claim was critical for establishing the TCFD while also its credibility being in turn enhanced through the work and existence of the TCFD. Thus, the emergence of the TCFD and the development of its recommendations constitute a successful translation process of the climate risk claim, lending themselves to an ANT-based analysis.

Identifying necessary adaptations of ANT in the context of climate-related financial governance, this paper argues that, first, spatial proximity allowing for face-to-face (F2F) interaction fulfils a crucial function in facilitating the translation of the climate risk knowledge claim and creating demand for the governance of climate risk. Taking the in ANT typically neglected factors of spatial proximity and F2F interaction seriously does not challenge ANT's basic ontological assumptions, however, but rather complements them. Second, the paper identifies some strengths and weaknesses of ANT in unveiling and interrogating power relations. These arguments advance ANT scholarship, human geography, and the environmental governance literature alike by pointing out pathways for translating ANT into a new research context.

2.2. Why use ANT?

Why translate ANT in the first place, however? Given its origin in natural science laboratories and engineering workshops, why use ANT for researching the TCFD and the finance-climate nexus? Fundamentally, ANT is built on three ontological pillars which match defining features of the TCFD and the emerging climate-finance governance sphere. In short, these three pillars of ANT are the "sensibility to the materiality, relationality and uncertainty of practices" (Law and Singleton 2013, 489).

What Law and Singleton (2013, 489) refer to as 'relationality and uncertainty of practice' captures how ANT conceives of agency. Reality is not made up of autonomous, well-bounded actors endowed with agency; it rather consists of relations between what might commonly be understood as actors – e.g. individuals – forming actor-networks. It is these relations through which agency – the capacity to affect

– circulates. This ontological tenet of relationality is interlinked with the one of uncertainty. Given that social relations can decay relatively quickly without constant maintenance work, this relational world is inherently precarious and fluid (Callon 1986; Latour 1987; 2005). This ontology makes ANT particularly attuned to processes of change and becoming such as the TCFD's emergence at the centre of this study. Furthermore, ANT's conception of social reality corresponds with the reality of the TCFD insofar as no single actor or entity has demonstrated the capacity to act autonomously by virtue of their own capacity. It is the tying of new relations that gives rise to agency. The TCFD itself is made up of representatives from corporations, financial institutions, and accounting firms pursuing a task delegated to them by the FSB which in turn is a group of central banks, financial supervisors, and finance ministries. Similarly, the changing membership of the TCFD, with – as of December 2021 – only 18 of the 32 members being left of the original cast in early 2016, correspond well with ANT's conception of the fluidity of relations.

With social relations being fluid and precarious, the relative stability of modern societies according to ANT rests on materiality, i.e. material objects functioning as “immutable mobiles” (Latour 1987, chapter 6) – the third ontological pillar of ANT. Relations – whether in the form of roles, dependencies, hierarchies etc. – are inscribed in stable matter – e.g. documents, maps, speed bumps etc. – and therefore stabilised across time and space without the need for constant direct interaction between the participating human actors. In fact, for Latour (2005, 202) the locus of direct interaction on a face-to-face basis to keep relationships stable is “implausible”. ANT is thus set on investigating how spatial distances are bridged, how one can “act at a distance” through objects (Latour 2005, 194–99) disregarding the role of spatial proximity. ANT thus abandons the primacy of human agency by conceptualising objects as elements of actor-networks equal to humans in their role to act and affect. This ‘sensibility to materiality’ seems well placed in the context of the TCFD as it is obviously interlinked with physical and thus material phenomena, i.e. the planet's climate, greenhouse gases, etc. This does not only hold for the climate side of the equation. The materiality of finance from computer screens to trading floor layouts and papers slips has been found to shape financial market practice in many instances (Beunza 2019; Knorr-Cetina 2005; MacKenzie 2004; 2021).

Scholar from multiple disciplines have warned against the increasing use of ANT, however. First, while the relational ontology of ANT has opened up countless fruitful ways of approaching space topologically, i.e. focusing on what remains stable independent of geographical space configurations (Law and Mol 2001; McFarlane 2009; Müller 2015b), this topological approach of understanding space in a sometimes purely metaphorical way focusing on its constitution by non-geographic relationships might have become too much of a fixture of ANT by now (in the sense of Law 1999) and has led to a

neglect of the materiality of space and its effects (Corpataux and Crevoisier 2016). This paper proposes a first step toward incorporating this critique into ANT by taking spatial proximity seriously.

Second, due to ANT's alleged neglect of structural power relations, scholars from multiple disciplines have questioned ANT's ability to facilitate critique (Koddenbrock 2014; Lave 2015; Mills 2018). While this criticism can and has been met on the theoretical level emphasizing e.g. ANT's capacity to unveil ontological politics (Mol 1999; Müller 2015b), this paper – in ANT tradition – operates on the level of empirics and demonstrates how certain dimensions and relations of power indeed can be made visible employing ANT while others cannot.

2.3. Methods

Three modes of data collection underpin the empirics of this paper: First, 63 semi-structured interviews were conducted between March 2018 and February 2021 with individuals either directly involved in the creation of the TCFD and/or its recommendations (37) or expert in particular dimensions of climate risk and the implementation of the TCFD recommendations (16). Second, participant observation at 15 practitioner workshops and conferences complements the interview data. Lastly, documents highlighted by interviewees supplement the data from interviews and observation.

The reliance of this paper on interview data is a necessity dictated by the nature of the research object: Both the setting up and the work of the TCFD were shielded from the public and thus not directly accessible. Thus, interviews remained one of the few methods left to access what cannot be observed (see Patton 2002, chapter 7). Interview data is not simply a second-best solution for ANT research, however, but a solid basis (see Fox and Alldred 2014) as it 'takes the actor seriously' as demanded by Latour (Latour 2005, 46–50).

Data in the form of field notes was generated during participant observation at 15 practitioner workshops and conferences dedicated to or also covering the topics of climate-related disclosures (see appendix). Field not data was used for limited but nonetheless crucial triangulation of interview data. It also provided the opportunity to develop a 'thicker' understanding of the output of the previous translation stages, i.e. of what had become fact and consensus already. It thus also allowed for a continuous verification of the crucial case design of this study monitoring whether the climate risk knowledge claim as well as the TCFD and its recommendations remained relevant and effective within 'green' finance. Participation at workshops and conferences also proved critical for engaging in conversations with actors that would or could not have been interviewed.

The documents collected helped to triangulate data from interviews and observation, especially around key events when new actors were enrolled into the climate-risk actor-network. Crucially, they

were often very much actants in said actor-network as for instance official letters of mandates written by the G20 or the FSB. Also, some documents captured the voices of actors who could not be interviewed for this study.

The data collected was coded using thematic analysis (Braun and Clarke 2006). In the spirit of ANT, open coding was conducted without introducing theory at this first stage of data analysis. During the first coding wave, 'place & space' was identified as category spanning multiple interview transcripts despite it not being addressed in any of the interview questions. Therefore, half-way through the data collection, one question specifically addressing the role of space and F2F interaction was integrated into interview guides.

With 1st wave coding instructing further data collection, i.e. an iterative moving between data analysis, reflection and data collection (Green et al. 2007), the depth and granularity of data around the role of spatial proximity and F2F interaction was enhanced. During subsequent coding, no new categories were created, however. Data segments coded as relevant for the already identified category were re-read and interpreted in an empathetic way (see Willig 2014) leading to the identification of roles of spatial proximity discussed in the sections below.

2.4. The emergence and work of the TCFD

Arguments around climate-related issues posing financial risks to fossil fuel companies have been promoted at the edges of financial markets since at least the 1990s. However, the articulation of this claim and what ANT calls the *problematization* (Callon 1986) of climate change as climate risk was not sufficient to ensure its translation into a widely accepted fact within finance. The perhaps first major publication formulating the climate risk claim in detail in 1994 – the Mansley (1994) report – was largely ignored:

"When we launched it [the report], um, we hired a hotel [...], and after a time, 15 minutes on, only one person had turned up. It was just a friend. Nobody turned up to read the report, nobody at all..." – NGO3, 24.04.2019

About two decades later, a turning point was reached in late September 2015 when Mark Carney (2015), the erstwhile Chair of the FSB and Governor of the Bank of England (BoE), declared climate-related issues a risk to financial stability. In this speech Carney announced the creation of what three months later would become the TCFD. With the most senior global financial regulator promoting the claim that climate issues posed financial risks the claim significantly gained in credibility and urgency. Indeed, both investors' and financial academics' attention to and engagement with climate risk is highly concentrated in the years after Carney's speech and the launch of the TCFD (see Venturini 2022).

Statements by David Cullen¹ – by the time global head of sustainable finance at an international bank and chair of a sustainable finance working group at a global financial industry association – on the TCFD being a “game changer”² and “the main driver”³ of engagement with climate risk both on the board level and on the operational risk management level are illustrative of a broad consensus in this regard among financial actors.

With the factuality of a statement depending on its broad acceptance and durability (Latour 1987), the TCFD thus functioned as engine for making climate risk a fact by making the claim more difficult to dispute and by translating it from the side lines of finance into the board rooms. The creation of an institution like the TCFD, however, would not be possible without the climate risk claim being accepted among key G20 and FSB constituents in the first place. The TCFD is therefore also an effect of climate risk becoming a fact. This poses the question what motivated the surge of regulatory support for the climate risk claim? The answer lies in actor-network formations in Paris and London.

2.5. London

Since the 1990’s various individuals in private finance in the City of London had been engaged in promoting arguments on climate change posing a severe risk to fossil fuel related asset. Climate policies limiting the amount of fossil fuels that could be sold and burnt would deflate the value of those assets. Initially, these arguments were either ignored or rejected. The group of proponents comprising individuals such as Mark Campanale, Nick Robbins, Jeremy Leggett or Nick Mabey – many of whom being motivated by a deep concern over the state of the planet’s climate – continued to promote the claim in their interactions with financial practitioners, however. These interactions were facilitated and underpinned by both newly founded organisational structures such as the Carbon Tracker Initiative and already established ones such as investment funds, large banks, or the UN. During these years, these proponents made two critical moves which ANT can help understand: the transformation of the rigid climate risk claim into a fluid *water object* and the *interessement* defining financial regulators as the actor group responsible for tackling climate risk.

First, the very nature of climate risk had to be adapted to the reality of the City of London to be convincing and thus to facilitate enrolment. Private financial market actors neither believed climate policies would be implemented which would destroy the enormous monetary value of fossil fuel assets nor did they have any interest in seeing such value destruction in their portfolios. Hence, the single future of climate policies bursting the carbon bubble was not deemed credible. Thus, the proponents started constructing alternative futures of both climate change being mitigated by means other than

¹ Pseudonym to ensure anonymity.

² Field notes, Climate Finance Day, 28.11.2018, Paris.

³ Field notes, Macroeconomic and Financial Stability Implications of Climate Change, 29.01.2019, London.

public policies and of unmitigated climate change and the detrimental implications such a future would have.

“So the critical piece for us was re-framing: [...] there are multiple scenarios some driven by technology [...] and some driven by climate impact which we can show you lots of evidence and you’re underestimating the impact.” – NGO6, 06.03.2020

Second, to cultivate a (self-)interest among private financial market actors in which of these multiple scenarios would eventually materialise, i.e. to assign those actors a more active role in the climate risk actor-network, the proponents developed two types of transitions towards a low-carbon future: an orderly and a disorderly one. With one being obviously more ‘investable’ than the other, financial market actors had an incentive to engage with the climate risk claim.

It was very clear they [investors and fund managers] were not buying the carbon bubble so in the meeting [...] we framed it as orderly versus disorderly transition. So again it's a different way of saying "Do you want- there's gonna be a transition. Do you want then that it is orderly enough that you can invest against it or so disorderly you just kind of invest because the future is unknowable." – NGO6,

06.03.2020

Thus, the critical move to break resistance by private financial market actors was to abandon the *immutable mobile* (Latour 1987, chapter 6) that was the original climate risk claim of a single climate future and to transform it into a fluid, adaptable claim – a *water object* characterised by an ability to change gradually and fluently (Law and Mol 2001; Law and Singleton 2005).

To ensure both the credibility of the climate risk claim and subsequent action, another move was necessary. *Interessement* refers to an intervention aimed at defining an entity’s identity in such a way so that it cannot be defined in any other way. In this instance, climate change – after having been problematized as climate risk – was now turned into a regulatory issue:

“the report [on climate risk] is actually a letter to financial market regulators. You remember it? All of it is addressed to financial market regulators, saying this is on your watch, this is your responsibility, this is gonna be your problem.” – NGO3,

24.04.2019

By arguing that current disclosure standards, valuation practices, and listing requirements were not fit for purpose to facilitate the management of climate risk, financial regulators and supervisors were put into the driver’s seat. Private financial market actors were effectively being prevented from co-opting

climate risk since the existing financial market infrastructure according to this narrative did not provide the necessary information and tools to them.

In 2013, a series of dynamics around and within the BoE started creating the conditions for this *interessement* to become a successful *enrolment* of the BoE into the climate risk actor-network, i.e. an acceptance of its role as responsible entity.

First, the UK government's Department for Environment, Food and Rural Affairs (Defra) invited the BoE to report on how it was adapting to the impacts of climate change. While this invite was not publicly acted on until the following year, it provided individuals within the BoE with a mandate to consider claims on climate-related risks. Simultaneously, the BoE underwent a more general transformation with a new Governor, Mark Carney, being appointed, the Bank's powers and responsibilities being expanded and an internal rethinking of the BoE's purpose being kickstarted which resulted in a broad and inclusive wording putting the British people at the heart of the BoE's mission (see Carney, 2014). Lastly, not just within the BoE but within the global financial supervisory community a shift in thinking had occurred since the financial crisis of 2008. The nearly exclusive focus on micro-prudential supervision, i.e. the supervision of individual financial institutions, was now being supplemented by a re-emancipation of a macro-prudential perspective (Mackintosh, 2017). This macro-prudential angle allowed central bankers and financial supervisors to also think about systemic risks which the structural mispricing of fossil fuel assets was being depicted as.

Thus, with external pressure from NGO and financial industry actors, an official mandate by Defra as well as organisational and cognitive shifts, a tipping point was reached. In 2014, the BoE officially launched a process to respond to Defra's invite resulting in a report laying the groundwork for the TCFD (PRA 2015) and making the BoE an official proponent of the climate risk claim.

2.6. Paris

2014 also marked the ramping up of translating the climate risk claim within Paris. The French government prepared for what was felt to be the last chance to reach a global agreement on tackling climate change: COP21. In this context, technocrats within the ministry for the economy and finance pursued a strategy to align financial market practice with climate goals – a strategy captured in article 2.1c of the Paris Agreement and already pursued earlier nationally as exemplified by article 173 of the French energy transition law. The climate risk claim fit into this wider strategy as it provided a narrative that allowed existing regulatory institutions to engage with the issue of climate change without crossing the lines of their legal mandates.

"He [the French finance minister] wasn't comfortable with the, uh, uncomfortable, with the fact that we are, we engaged only, we only had a private sector

dimensions agenda [for COP21] and had nothing that related to uh, to policies that we need from the finance ministers. [...] Um, and it was in that context that the idea of us mobilising the FSB was first mentioned [...] So we had to frame the discussion, uh, in terms that were completely consistent with the core mandate [...] the discussion of mission creep was already something we were very sensitive of but comfortable with because we, we put things in a way that, uh, we thought were completely within the remit and under the mandate of the FSB or financial regulator.” – FinancialRegulator7, 06.02.2020

To scale up the strategy of making climate considerations part of financial market practice, a team of French technocrats and diplomats started translating the climate risk claim into other G20 member governments through personal relations to their counterparts in other countries as well as through diplomatic channels. Apart from enrolling key G20 members into their network, they also approached the Governor of the FSB, Mark Carney, to gauge whether the FSB was willing to engage with climate issues. The success of this translation attempt is manifest in a G20 mandate issued in April 2015 for the FSB “to convene public- and private-sector participants to review how the financial sector can take account of climate-related issues”⁴.

Following this mandate, the BoE in September 2015 hosted a workshop including industry representatives and FSB members which aimed at re-enforcing the climate risk claim within the ranks of the FSB and while narrowing down the broad G20 formulation to a workable task all FSB members could agree on. Disclosure guidelines for climate risks had been discussed and demanded for years at this point (see e.g. Carbon Tracker Initiative 2011) making it an obvious, yet a lowest-common-denominator answer to this question. To appease FSB members reluctant to see the FSB engage with climate-related issues such as Saudi Arabia or India, this task was then further outsourced to an industry-led task force which gained authority from the regulatory shadow of the FSB but remained outside of its structures making its outputs not automatically endorsed by all FSB members. Seeing this design of the TCFD exclusively as strategy to circumvent or appease veto players within the FSB would be too simplistic, however. Rather, industry-led initiatives were also the preferred modus operandi of the FSB Chair Carney who had tested this model before in banking disclosure through the FSB’s Enhanced Disclosure Task Force (EDTF) which served as blueprint for the TCFD.

The TCFD then started to be run by a secretariat of financial regulation experts led by former SEC Chair Mary Shapiro and paid by Michael Bloomberg, founder of the financial data service empire. While Bloomberg’s involvement lent further credibility to the TCFD due to his standing in the business world,

⁴ <http://www.g20.utoronto.ca/2015/150417-finance.html> [21.01.2022]

more importantly his financial resources facilitated a highly effective management of the process. Between early 2016 and summer 2017, elites from financial and resource-intensive industries acting as pro-bono members of the task force supported by the Big Four accounting firms and the TCFD secretariat drafted and consulted on what was published in June 2017 as the final recommendations. When those were endorsed by the G20 that summer, climate risk had become a fact for global financial markets.

This section demonstrates the analytical value of ANT. Its relational ontology focused the analysis on the tracing of ties and relations regardless of the analytical scale. Thus, the work of making climate risk a fact becomes visible in all its localities from individual interactions between NGO representatives and financial practitioners to G20 diplomacy rather than confining analysis to the micro or the macro level. ANT's sensitivity to the precarity of relations sharpened the analytical lens to capture both the failures of translating climate risk and the adaptive moves necessary to ultimately achieve success. Lastly, the conceptualisation of agency as a consequence of network relations facilitated the development of a fine-grained picture capturing the multitude of individuals, organisations, mandates, and reports that had to come together to successfully translate climate risk and create the TCFD challenging the idea of primacy of any actor in this process.

2.7. Acting face to face

Key pieces of the puzzle how the TCFD was created and climate risk translated do not readily fit into an ANT analytical frame, however. Still, ANT's attention to detail and its radical empiricism forms the very basis for identifying its own shortcomings. A red thread going through nearly all the phases and events described above is the role of F2F interaction in enrolling key players into the actor-network. Thus, translating climate risk was not just an effect of the right arrangements in a relational space. This relational space in turn depended on certain arrangements in physical space, i.e. on spatial proximity of individuals. In short, spatial proximity allowing for F2F interaction gives rise to two sets of dynamics that proved critical in facilitating the enrolment of new actors into the climate risk actor-network.

2.7.1. Facilitative dynamics

Multiple academic disciplines acknowledge how F2F interaction enhances communication. For instance, facial expressions and gestures are more accessible to the interlocutor thus conveying non-verbal information.

“My life is a lot – now it is [laughs] – Skype meetings and Zoom meetings and Teams meetings. Um, I’ve always been a big fan that it feels much more meaningful to be in a room, getting to see people, getting to see their expressions,

getting to know somebody. Um, and these meetings allowed for that.” –

TCFDmember12, 07.04.2020

F2F interactions are also more likely to facilitate informal conversations, e.g. on the side lines of a formal meeting, exchange of sensitive information or information that could be termed gossip (Broadhurst and Mason 2014; Perkins and Nachmany 2019; Urry 2003). An interviewee remembering how the term ‘unburnable carbon’ was coined at a private cocktail party illustrates the value of such F2F communication. Given the information value investors and analysts see in F2F meetings with company executives, enhanced communication in such meetings also seems to be acknowledged and valued amongst finance professionals (see Roberts et al. 2006). Under conditions of spatial proximity, communication can also be enhanced through unintended or unplanned encounters facilitating the spontaneous exchange of information which meaning or usefulness could not have been determined prior to the encounter (Sassen 2001; Storper and Venables 2004). F2F interaction can even facilitate communication on topics which would have otherwise not been discussed as the following quote by a finance professional involved in translating the climate risk claim into the BoE illustrates.

“So there were quite a few naïve but, you know, not absolutely necessary questions for them [BoE staff] to ask. And obviously it is much easier to ask a question in a, you know, seemingly obvious question, in a sort of safe space in a small, in a small meeting.” – FinancialInstitution5.2, 16.03.2020

Thus, whether it is formal or informal, intended or unintended, spatial proximity can be an important component in bridging knowledge gaps and align *sociologics*, i.e. individual rationalities characterised by the ability to comprehend and make rational connections between observations or arguments but differentiated by different starting points due to differences in pre-existing knowledge, beliefs etc. (Latour 1987, 195–205).

Related to this is the second facilitating dynamic identified: the building of trust. Again, various disciplines note how F2F interaction supports the building of mutual trust thus lowering uncertainty for future interactions and further deepening communication (Broadhurst and Mason 2014; Holbrook, Green, and Krosnick 2003; Jones 2007; Urry 2003). Findings in experimental psychology showing how individuals tend to be more cooperative after F2F versus telephone conversations (Drolet and Morris 2000) are mirrored by research on investor meetings and the development of trust relationships among finance professionals (Cook et al. 2007; Jones 2007; Roberts et al. 2006). Similar findings on diplomacy suggest that F2F interaction can facilitate a mutual understanding of each other’s intention (Holmes and Wheeler 2020). In fact, generating trust through F2F meetings proved to be an ingredient

in different stages of the climate risk translation process. For enrolling industry and supervisory actors into the climate risk actor-network at the early stages, one interviewee involved in this process stated:

“[Y]ou'd have to have legitimacy, trust and fact. All the reports really give you is fact. Um, and legitimacy and trust; legitimacy may just come from a brand [...]; trust is something that is face-to-face.” – NGO6, 06.03.2020

The F2F meetings of the TCFD translating the climate risk claim into technology fulfilled similar functions according to multiple participants:

“And every time you went into the, um, the taskforce meetings, uh, Mary Schapiro would just say, let's just remember, you know, if you think you're going to get everything you want out of this process, you probably shouldn't be part of it. [...] and so what was built was a real, um, collegiate atmosphere of trust. Wasn't there on day one. You know, trust in groups gets built over a period of time.” – TCFDmember3, 21.03.2019

Within an ANT framework, this function of spatial proximity can be understood as allowing human actors to develop the confidence that being enrolled in the actor-network in question does eventually enhance their agency. As Latour (2005, 213–18) highlights, ties within an actor network facilitates agency for some but might be restrictive for others. Determining which one is the case in any given situation seems to be made easier for human actors F2F interaction.

2.7.2. Forcing dynamics

While the facilitative dynamics of F2F interaction are understood in different academic disciplines, the second set of dynamics following a forcing rather than a facilitative logic are not.

First, at multiple occasion throughout the translation process, moments of F2F interaction seemed to force key actors to make decisions on whether to enrol in the actor-network and promote the climate risk claim or not. Convincing Mark Carney to act on climate risk seemed to – at least partially – be triggered by a situation under conditions of close spatial proximity with other elites (on this see also Carney 2018).

“[T]he other thing which was pivotal, is that the Prince of Wales has, sort of, a private dinner at Clarence House, which I attended. Governor Carney was the principal guest. This was a discussion around these sorts of issues [climate change]. We had the dinner, when people thought they were going home the governor was asked a very direct question by the Prince: "So governor what are you going to do about this?" And half an hour later the governor eventually

committed to go and talk to the CFO of the World Bank and that led to eventually TCFD being created.” – TCFDmember6, 25.04.2019

Later on, when other FSB members or industry peers had to be enrolled in the actor-network, similar dynamics seemed to have been at work.

“Do you care enough to block this? [...] What we’re giving you is a sensible narrative. Are you gonna take it? And, you know, it’s much harder to make some niggly...you know, they’re not major objections, just sort of niggly little points...you can do that via email forever to, you know, not have to confront the point where you like...you know, is this a yes or is this a no? Whereas if you are in a room it’s much, um, yeah I think the dynamic is obviously different.” –

FinancialInstitution5.2, 16.03.2020

Thus, spatial proximity seems to create a situation in which certain evasive or objection strategies do not appear reasonable any more given the potential loss of respect with peers or the risk of being called out on simply avoiding certain decisions. It thus creates clarity on whether a particular translation strategy is successful or not, thus accelerating the overall translation process.

Second, F2F interaction enforces a focus and attention. As noted in the context of large-scale surveys, interviewees tend to be less engaged and put less cognitive work in answering questions compared to in-person interviews (Holbrook, Green, and Krosnick 2003). Also, Storper and Venables (2004) note that free-riding in shared projects is disincentivised by F2F meetings. These dynamics also seemed to affect the climate risk translation process.

“The task force did a good job at calling on people. So it was pretty hard to go on to these meetings and put your head down and work on other things or, you know, go take conference calls outside the room. Uh, people were engaged. They were expected to be engaged. Some of that I think was Mary. You know, Mary Shapiro is a pretty impressive individual. You’re not going to start responding to emails with Mary sitting across from you. You just...not gonna do that.” –

TCFDmember12, 07.04.2020

While the above quote as well as the literature cited highlights external motivators focusing actors' attention, spatial proximity can also trigger internal forcing of attention. By designing moments of corporeal copresence in ways that convey to the participants a sense of importance or meaning, spatial proximity can motivate actors to self-discipline. During the climate risk translation process, this was

achieved by e.g. ensuring the presence of high-profile individuals at meetings such as Michael Bloomberg or Mark Carney, and also by the choice of venues.

“And there was a sense of, erm, also finding different locations, so it was symbolic: The very first EDTF meeting was held in [company name], in our boardroom, and [name] the first finance director personally attended, that was a clear message, and that's one of the things I said to [name of a member of the TCFD Secretariat], the very first meeting needed to be in a really important place and it needed to be some personal presence to make sure people understand this.” – TCFDmember6, 25.04.2019

Enforcing focus and attention through spatial proximity thus essentially stabilises and strengthens the embeddedness of different actors into an actor-network, ensuring that the resources, skills etc. an actor was enrolled for are actually being made effective. Being physically exposed to an audience of one's (speech) act affects this very act itself with social scripts, conventions, peer pressure etc. becoming effective (Mazzone 2020, 8-10).

To summarise, spatial proximity allows for different facilitative and forcing dynamics to occur (see table 2) which in turn act as facilitator or catalyst for the expansion of actor-networks and the translation of knowledge claims. Thus, these findings build and expand on previous research identifying the relevance of F2F interaction in early-stage innovation processes by spelling out the dynamics through which F2F can facilitate and speed up knowledge translation (Huber 2012; Jones 2007; Torre 2008). While F2F interaction itself might not be a sufficient condition for a translation attempt to be successful, the different ways of facilitating and speeding up translation through F2F interaction appears to be non-trivial; particularly in a timing-sensitive context such as regulation and governance (see e.g. Lall 2015). As one TCFD member phrased it, the simultaneity of the French COP presidency, the British chairmanship of the FSB, the building up of external pressure on the BoE at the right time etc. all seem like a “planetary alignment” for which accelerating and catalytic dynamics should not be underestimated.

This importance of F2F interaction for establishing consensus and thus diffusing knowledge claims critical for the initiation and design of governance institutions such as the TCFD has implication for the current context of the Covid-19 pandemic. In settings where more fundamental gaps between the respective participants' *sociologics* need bridging, a fast pace is necessary, or early-stage innovation is to be fostered, F2F interaction might be a crucial ingredient for success with the pandemic hampering progress.

Dynamic type	Dynamic	Function
Facilitative dynamics	Enhanced communication	Aligning <i>sociologics</i>
	Building trust	Building confidence on agency enhancing character of actor-network
Forcing dynamics	Making decisions	Creating certainty around the effectiveness of translation strategies
	Focusing attention	Making ties within an actor-network effective

Table 2: summary of F2F dynamics

2.8. Bringing spatial proximity into ANT

With spatial proximity and F2F interaction being – at the very least – such a crucial lubricant for translation and yet side-lined in the core ANT literature, is ANT simply incompatible with the findings presented? Does ANT's focus on the role of objects keep it from accounting for the more human-dominated aspects of early-stage innovation and translation processes? Indeed, ANT's conceptual attention is centred on the idea of acting-at-a-distance, i.e. spatial distance, discarding F2F interaction as relevant only for stabilising relations within baboon communities but within modern human societies (Latour 2005).

Taking the role of spatial proximity and F2F interaction in translation processes seriously does not contradict ANT's tenets in any way, however, but rather complements them in three ways. First, it aligns and complements ANT's relational ontology by identifying when and how the Euclidian space becomes relevant to the relational space at the centre of ANT. Spatial proximity in the Euclidean space is still not of intrinsic relevance but – as shown above – gains its significance from affecting the relational space. While Law and Mol (2001, 611) focused primarily on the effects of configurations in relational space on dynamics in the Euclidean space, this paper's findings on reverse effects complements rather than contradicts their key message that “[s]patiality is an aspect of network stability”.

Second, the significance of materiality at the heart of ANT is affirmed by this paper's findings as F2F interaction is chiefly characterised by its material essence, the physicality of bodies and their proximity. Precedencies for ANT engagement with the physicality of bodies are legion (see e.g. Mol 2002) but typically focused on aspects of human health and medical science. This paper calls for an extension of this attention to the physicality of humans.

Third, ANT's concern with the overcoming of distance also motivates the discussion of F2F interaction and spatial proximity in this paper. It complements ANT's focus on action-at-a-distance by identifying

dynamics through which distance-at-an-action (Bridge 2021), i.e. disconnectedness preventing action, can be overcome. This paper argues that such relational distance, e.g. on the level of *sociologics*, can be bridged by the dynamics facilitated by spatial proximity.

Thus, the relevance of spatial proximity and F2F interaction does not fundamentally challenge any of ANT's ontological tenets but rather extends and complements them. After all, even Callon (1986, 210) in his seminal paper on the scallops of St. Brieuc Bay mentions the role of meetings and in-person presentations, without analytically interrogating these moments thoroughly, however. Why did the scientists in his study not simply post their reports and papers to the fishermen but held multiple meetings instead? This paper closes this gap in ANT's conceptual framework and draws attention to: First, the necessity to more holistically account for physical space within ANT and moving beyond spatial distance; second, how the concept of physical materiality can be fruitfully extended from non-human actants to humans to gain a deeper understanding of agency facilitated through actor-networks; third, how this human materiality and thus spatial proximity seem to be particularly valuable as analytical categories when exploring translation processes involving knowledge claims not yet codified or made material in any other ways, i.e. early stage innovation and knowledge translation.

2.9. ANT and power

The identification 'facilitating' and 'forcing' dynamics naturally poses the question: Facilitating for whom? Who is forcing whom? What kinds of power relationships do these dynamics create or foster? Answering these questions with ANT means to focus on the actual empirical manifestations of power relationships and their contingent, malleable nature. By doing so, ANT avoids getting stuck in the overtheorized dichotomy of centralised versus dispersed power (Allen 2004; 2008). This approach allows to identify two types of heterogeneities of power relationships unearthing the messiness of actual manifestations of power on the micro-level: directional and modal heterogeneity.

This paper defines directional heterogeneity as the diversity of directions in which influence is exerted. When located on a scale of how powerful intuitively an actor might be – due to e.g. formal authority, material wealth etc. – any actor can in theory exert influence upwards, i.e. influencing more powerful actors, downwards, i.e. influencing less powerful actors, and laterally, i.e. influencing actors that can be considered intuitively equally powerful. During the process of translating the climate risk claim, power relationships in all direction are not just observable but were indeed critical to the success of key translation attempts: The 'upwards' relationships of NGO representatives convincing large private financial institutions as well as the BoE of the validity of the climate risk claim were integral. It is critical to note in this context, however, that limits to this upwards exertion of power exist in the form of barriers to interaction, specifically the crucial mode of F2F interaction mostly restricted to individuals with considerable social and cultural capital linked to persistent structures of inequality. Once the BoE

and the G20 were enrolled, the relationships between enrolled FSB members, e.g. from the UK or the Netherlands, and those resisting the translation showcase how equal members of the FSB influenced each other, eroded resistance, and exerted power laterally. During the process of drafting the actual disclosure framework, the TCFD in turn was not entirely free in its choices. In fact, the FSB at multiple occasions subtly but clearly communicated that certain topics or items must or must not be part of the TCFD's final recommendations; a clear case of 'downwards' power relationships flowing from the global financial markets watchdog to its subsidiary task force.

Modal heterogeneity captures the two modes in which power relationships can become effective: Power might be exerted over or with somebody, i.e. in a mode of domination or facilitation (Allen 2009; Rutland and Aylett 2008). In the case of the TCFD, relationships of domination are typically underpinned by legal authority structuring the whole design of the climate risk actor-network by defining institutions (e.g. the G20) and mandates which need to be cleared or complied with to further proceed with the translation. Facilitative relationships took two different forms: negotiating and arguing.

"I remember having breakfast with one of the final people who was not sure he could sign [the final TCFD recommendations] and I asked him what the issues are and then one by one, we tried to resolve them. But that's what's needed. It requires, over and above, actually the physical time in the room [...] to problem-solve outside of the room, to do the heavy lifting. Just like any international agreement apparently." – TCFDmember6, 25.04.2019

This quote, characterising the type of negotiations within the TCFD as problem-solving endeavour, illustrates its facilitative nature. Interests or positions were not abandoned under pressure but were aligned via concessions so that actors had their concerns acknowledged.

Arguing might often be part of negotiating. Conceptually, however, it is fundamentally different in the sense that the participating parties are willing to adapt their identities, i.e. their values and worldviews, during the course of the argument (Risse 2000). By enabling the participant to voluntarily enhance their own knowledge or worldviews based due to convincing arguments, the other party does in no way dominate but rather facilitate the understanding of the counterparty while still pursuing their own goals. This facilitative mode of power relations proved particularly crucial during the very early stages of translation when NGOs attempted to convince industry representatives of the climate risk knowledge claim:

"So we ended up in that kind of "You prove to me that climate policy is gonna burst the bubble". And that was an unwinable argument because most people in

the financial system were deeply- are deeply sceptical about public policy, [...] and assume it's never gonna happen. [...] You know it's something where you cannot win the argument..” – NGO6, 06.03.2020

This brief summary of heterogeneities of power relationships made visible by ANT's sensitivity to the relational and the micro-empirical unveils some of the complexities at danger of being overlooked by more structural or overtheorized approaches. More importantly, it confirms not only the presence and effectiveness of lateral and upwards power relations but also identifies the avenues of facilitative power available to forge such power relations beyond expectable downwards relations of power.

However, ANT suffers from two significant constraints when analysing power relations. Unlike past critiques of ANT (Koddenbrock 2014; Lave 2015; Mills 2018), these constraints are of practical rather than theoretical nature. First, ANT tends to rely on objects, i.e. non-human actors, for identifying and tracing ties to far-away actors who still affect the domain of interest. Given the main argument of this paper, however, i.e. the importance of spatial proximity and F2F interaction in translating the climate risk claim, this reliance on objects to trace 'long' ties becomes problematic. 'Long' ties internalised by human actors in a Foucauldian sense could very well shape translations and actor-networks in significant ways without ANT providing a conceptual toolkit to unearth and analyse them. In fact, Latour (2005, 204–13) somewhat acknowledges the possibility of human actors 'downloading' what he calls 'plug-ins', i.e. internalising external interests, values, ideas etc. without discussing how to investigate such ties that – while not observable as material objects – clearly affect translation.

Second, ANT is practically limited exactly where it claims to facilitate critical social science. By focusing on controversies, i.e. "staying with the trouble" (Law and Singleton 2013, 488), ANT scholars want to trace ontological politics, the conflicts around foreclosing some realities and pursuing others (Mol 1999). ANT's meticulous attention to micro-empirics bears the danger of exclusively focusing on the controversies unfolding in the immediate research domain. Controversies successfully blocked and banned from whatever the ANT scholar chooses as their bounded research object are at risk of being neglected. Excluded dissent becomes muted. In the case of this study, for instance, the choices of the author when and where to stop tracing the ties of the actor-network resulted in the exclusion of the fundamental controversy around who benefits and who loses by conceptualising the finance-climate nexus in terms of risk (Christophers 2017; 2019).

Bringing these insights together – ANT's ability to make visible the heterogeneous manifestations of power relationships and ANT's inability to account for 'long' ties and disconnected controversies – it becomes clear where ANT's strengths lie: in tracing the micro-struggles within a bounded system, reformist transformations within an organisational field where material and legal power asymmetries

can be overcome through negotiation and arguing, i.e. “sub-politics” (Callon 2009, 542). However, the greater the distance between any two ends of a power relationship, the more laborious it is for ANT to account for those relationships where they are not mediated by observable objects. Thus, an ANT scholar might lose sight of more fundamentally opposed or decoupled fields and their respective power relations and thus miss key moments of ontological politics.

2.10. Conclusion

The sensitivity to knowledge and technologies changing in nature and effect when being translated across time and space is at the heart of ANT. It would be ironic if this sensitivity was not applied to ANT itself when used outside of the sciences laboratories and engineering workshops it was designed for. ANT needs to be adapted to the structurally different research spaces of human geography and environmental governance both from a conceptual and an empirical angle. This paper walks the latter path thus providing insights into the relationship of ANT with two concepts central to human geography: space and power. Regarding the former, it finds that in the context of turning the claim that climate change poses financial risk into a fact and a governance technology, spatial proximity and F2F interaction are of great significance contrary to what foundational theoretical texts in ANT suggest. Accounting for interactions under conditions of spatial proximity reveals dynamics critical for the success of translation strategies.

The relative importance of such mechanisms might be symptomatic of an inherently more human-centred research object. When researching environmental governance employing ANT “we might come to the conclusion that Nature does not play the hegemonic part in politics as ANT initially reckoned it did” (Asdal 2020, 343). The relevance of F2F interaction might equally be connected to the stage of the translation process this paper focuses on, i.e. early-stage innovation.

Regarding the concept of power, this paper demonstrated ANT’s strength of bringing to light a heterogeneity of power relations while also identifying some fundamental practical constraints of ANT. Together, these two findings on power suggest that ANT is particularly well suited to examine knowledge and translation struggles within a bounded system, i.e. reformist struggles around incremental transformations, rather than knowledge clashes of fundamentally distinct and opposed systems.

Lastly, beyond advancing theoretical debates on the use of ANT within human geography and environmental governance scholarship, this paper makes substantial empirical contribution to the understanding of the finance-climate nexus. By doing so, it aims at providing an entry point for critical geographers to debates on climate risk within finance currently dominated by economists and finance and accounting scholars with only few notable exception (Christophers 2017; 2019). Critical

geographers have demonstrated the merit of their analytical tools in interrogating the risk approach to nature in other contexts (see e.g. Dempsey 2013). This agenda needs expanding to the phenomenon of climate risk increasingly structuring the relationship between finance and the planet's climate.

Appendix

Title	Location	Host	Date
Green Finance Summit 2018: Mainstreaming Green Finance	London, UK	Green Finance Initiative / City of London Corporation	Jul 17, 2018
Scaling Up Green Finance: The Role of Central Banks	Berlin, Germany	Council on Economic Policies / Deutsche Bundesbank	Nov 8-9, 2018
PRI Climate Forum	London, UK	PRI	Nov 26, 2018
Green Finance Research Advances	Paris, France	Institut Louis Bachelier / Banque de France	Nov 27, 2018
Climate Finance Day	Paris, France	UNEP FI / Finance For Tomorrow	Nov 28, 2018
3rd Meeting of the UK-China Green Finance Taskforce	London, UK	Green Finance Initiative / Green Finance Committee (China Society for Finance and Banking)	Nov 30, 2018
Promoting Sustainable Finance	Brussels, Belgium	Technical Expert Group on Sustainable Finance / JRC Community of Practice in Financial Research	Jan 8-9, 2019
Macroeconomic and Financial Stability Implications of Climate Change	London, UK	Bank of England	Jan 29, 2019
Central Banking and Sustainability – A Roadmap to 2020	London, UK	Finance Dialogue / New Economics Foundation	Mar 19, 2019
Climate-related Financial Reporting Conference	Cambridge, UK	University of Cambridge / ICAEW / University of Zurich	Apr 2-3, 2019
NGFS Conference	Paris, France	NGFS / Banque de France	Apr 17, 2019
Green Finance Summit 2019: Investing in Action	London, UK	Green Finance Initiative / City of London Corporation	Jul 2, 2019
The Climate Risk and Green Finance Regulatory Forum	London, UK	City & Financial Global	Nov 19, 2019

UNEP FI Regional Roundtable Europe: Breakthroughs in Sustainable Finance	Luxembourg City, Luxembourg	Luxembourg for Finance / UNEP FI	Nov 28-29, 2019
A4S Forum 2019	London, UK	A4S	Dec 11, 2019

Table 3: list of observed events

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3. Whose climate risk? Unpacking the interest constellations that shaped the TCFD's climate risk disclosure framework

Abstract

Climate-related disclosure currently constitutes the primary governance approach by central banks and financial supervisors in addressing climate change. The recommendations by the FSB's Task Force on Climate-related Financial Disclosures have established themselves as global standard for such disclosures. This paper traces the process of how the TCFD recommendations were developed. Employing the methodological sensitivities of ANT, the paper identifies key points of contestation in the industry led TCFD process and finds shifting alliances and oppositions drawing conceptions of the representation of industry interests into question. It argues that while the TCFD membership was recruited explicitly to represent 'the market', positions taken by TCFD members cannot be explained by the mere representation of organisational interests of market participants. Interests pertaining to the collective good played a significant role in structuring contestations and indeed shaping crucial aspects of the TCFD recommendations. These contestations of and effects on the TCFD recommendations do not only provide insights into the ontological politics of climate risk in the context of disclosure frameworks but they also hold broader lessons for a more nuanced understanding and critique of industry-led governance initiatives. While the TCFD recommendations are unlikely to facilitate market-based mitigation of disastrous climate risk, they do not neatly fit the picture of neoliberal governance dominated by the interests of corporate market participants. Individuals as carriers of interests need to be taken seriously.

3.1. Introduction

In September 2015, Mark Carney as the erstwhile Chair of the Financial Stability Board (FSB) – the global financial markets watchdog created after the 2008 financial crisis (Mackintosh 2017; Moschella 2013) – confronted financial markets with the claim that they had collectively neglected a systemic financial risk: climate risk (Carney 2015). Such climate risk could materialise in the form of transition risk, i.e. the move to lower carbon economies via climate policies, technological change or shifts in consumption patterns affecting asset prices, in the form of physical risk meaning physical impacts of climate change such as droughts, floods, or storm events potentially destroying assets, and in the form of litigation risk where companies face law suits for their climate impacts (PRA 2015). Given the failure of financial markets to properly account for such climate risks, the FSB launched a task force to address this issue just a few months later: the FSB's Task Force on Climate-related Financial Disclosures (TCFD).

While the TCFD as an industry-led task force which was endorsed but not formally part of the FSB could only issue non-binding recommendations, its impact on the governance of climate risk and thus of a crucial intersection of finance and the planet's climate has been significant in two ways. First, it defined a space for policy action, namely climate-related disclosure regulation as opposed to, for instance, credit guidance or capital requirements, which is currently the primary and, in many jurisdictions, the sole area for financial supervisors and regulators to govern the relation of finance and climate change (see e.g. Ameli, Kothari, and Grubb 2021). Second, the TCFD's recommendations are by now set to become mandatory disclosure requirements across key financial markets from the UK to Singapore, the EU, and most recently the US (TCFD 2021a). Thus, the TCFD has established itself as a pivotal private governance institution at the intersection of financial markets and the earth's climate.

This paper investigates how the TCFD as private governance institution developed its disclosure recommendations and thus effectively defined what counts as climate risk and how to account for it. Empirically, it therefore unpacks the genesis of a central governance tool in the finance-climate nexus thus facilitating a more forensic critique. Conceptually, this study advances the literature on private transnational governance by unpacking the interest constellations of controversies during the development of the TCFD recommendations. It challenges the notion of individuals involved in private governance simply representing the interests of the organization they formally represent and argues that to fully understand the genesis of private governance outputs and thus the potentials and limits of private governance, the role of individuals and their interests need to be taken more seriously. These findings have implications for how we understand the representation of interests in transnational governance.

3.2. Private governance, representation, and interests

The rise of private governance arrangements over the past few decades has sparked wide academic interest (Auld and Gulbrandsen 2013; Bäckstrand et al. 2017; Biermann and Pattberg 2012; Bulkeley et al. 2014; Dingwerth 2007; Green 2014; Hall and Biersteker 2002; Hurrelmann et al. 2007). The literature thus produced has shown the political nature of both private governance processes and outcomes despite the content often being perceived as technical, whether in the context of financial governance such as e.g. privately set financial accounting standards (Botzem 2012; Lagneau-Ymonet and Quack 2012; Ramanna 2015), in the context of environmental governance such as e.g. sustainability standards (Judge-Lord, McDermott, and Cashore 2020; Klooster 2010; McCarthy 2012), or at the intersection of finance and the environment as in the case of green bond standards (Park 2018; Perkins 2021). This political nature of private governance has attracted scholarly inquiry around the boundary conditions within which private governance emerges and persists (Abbott and Genschel 2015; Green 2014; Hall and Biersteker 2002), its multiple pitfalls and shortcomings (Bäckstrand and Kuyper 2017; Galland 2017; McCarthy 2012; Ruysschaert and Salles 2014; Silva-Castañeda 2012; Underhill and Zhang 2008), as well as the processes of negotiation and contestation between interest groups involved in the private governance process (Klooster 2010; Ponte and Cheyns 2013). This latter area of research is where this study adds to the existing literature by unpacking the interests and interest coalitions affecting the output of private transnational governance processes.

The value of unpacking, i.e. of a more granular analysis of, the private interests, actors, and coalitions active in private governance has been demonstrated both in the context of financial and environmental governance. Interests of what could be conceived as homogeneous actor groups such as corporations, NGOs, or public regulators have been shown to be diverse and heterogeneous instead. Firms' interests can diverge significantly depending on their geographical locations, their positions within value chains, or the political context they are embedded in (Falkner 2012; Woll 2008). Equally, technocratic standard setters within international bodies can be divided along geographical and cultural lines instead of forming a homogeneous epistemic community (Goldbach 2015; Morley 2016). NGO interests, often seen as counterweight to industry (Boström and Hallström 2010; Judge-Lord, McDermott, and Cashore 2020), do not always fulfil this expectation with global NGOs potentially aligning their language and culture with those of global corporations rather than those of local or other marginalised interest groups within private governance processes (Ponte and Cheyns 2013). Furthermore, interests do not just vary within actor groups but also over time with both public and private actors changing their preferences on regulatory issues as contextual factors change (Brooks 2021; Mügge and Stellinga 2015) sometimes giving rise to "coalitions of the unlikely" (Monciardini 2016).

Thus, the unpacking of interest constellations in private or hybrid governance has advanced and produced valuable insights on their determinants, heterogeneity, and effects. However, this unpacking has stopped short of investigating the direct social interactions of interests meeting and clashing over governance decisions, i.e. of observing interests on the level of individuals negotiating and arguing about policies. The organisation, whether an NGO or a transnational corporation, is typically treated both conceptually and empirically as the relevant actor and thus carrier of interests in private governance (Pattberg 2017; Ruggie 2018; Scherer, Palazzo, and Baumann 2006). If at all, individuals are only considered as consumers, i.e. as targets of governance (see e.g. Grabs, Auld, and Cashore 2020). Several sub-strands in the literature on private and hybrid governance initiatives resembling the TCFD hint towards this omission being problematic.

First, the TCFD in some ways resembles multi-stakeholder initiatives (MSI), i.e. arrangements in which diverse actors self-regulate an issue they all have an interest in. The TCFD consists of resource intensive companies, financial institutions, and service providers, i.e. a diverse set of actors with different interests in climate-related disclosures. The literature on MSI by and large treats organisations or even organisation types as relevant carriers of interests assuming that an organisation's membership in a MSI implies the representation of its interests (Dingwerth 2008; Fransen and Kolk 2007; Zeyen, Beckmann, and Wolters 2016). A study by Reinecke and Donaghey (2021) exploring how workers' interests are being represented in a MSI by NGOs and labour unions – while still treating organisations rather than individuals as actors and carriers of interests – indirectly challenges this notion, however. By employing the concept of discursive representation developed in the context of deliberative democracy (Dryzek 2002; 2010) the authors show how the representation of interests is not simply dependent on seats formally filled in a MSI but rather on ideas, arguments, and views actually being articulated in the debate.

Second, the TCFD depicts itself and wants to be understood as an expert body (TCFD 2017a, 3). Some literature on such expert bodies also encourages a closer look at the role of individuals, their votes and decisions rather than their organisational affiliations. For instance, individuals associated with the petroleum industry supported rather than resisted calls for removing lead from petrol within the UK's Royal Commission on Environmental Pollution (Owens 2012, 17). In international accounting standard setting, country-specific professional norms rather than just organisational affiliation have shown to shape individual standard setters' and technical staff's preferences on standards within the International Accounting Standards Board (IASB) (Morley 2016).

Lastly, the TCFD, run and populated by a group of financial and corporate elites, could be conceptualised as an elite project to establish a new command post to control an emerging governance space (Zald and Lounsbury 2010). The literature on elites has increasingly turned away from individuals

as autonomous carriers of interests and has come to understand them as conduits rather than wielders of power (Davis and Williams 2017). However, Tsingou (2015) shows how elites can iron out differences and homogenise their views within clubs thus weakening differences related to organisational affiliations, indicating again how such organisational affiliation might not be the only or even the most important determining factor of individuals' views and interests.

To synthesise, the literature on private governance thus shows that interests shaping governance outputs diverge within types of organisations. Also, multiple studies point towards the possibility of individuals involved in governance initiatives not unambiguously representing the interests they claim to represent or they are formally affiliated with. This points to the need to empirically determine the interests members of a governance initiative promote rather than inferring them from affiliation or status to understand the shaping of governance outputs, representation, and marginalisation in private governance. Such determination needs to happen by observing interests in action, i.e. where interests actually shape governance rather than where interests are merely uttered on a front stage of governance. Interests in action become most visible and linked to specific actors where they clash and contrast with one another, i.e. in controversies during the policy development process. Thus, this paper traces controversies during the process of developing the TCFD recommendations to show that while organisational representation and the fault lines identified in the private governance literature matter, individuals can have autonomy and are a relevant carrier of interests, too.

3.3. Actor-Network Theory, controversies, and interests

Actor-Network Theory (ANT) or what was originally called a sociology of translation (Callon 1986) is a conceptual framework made for the tracing of controversies (Venturini 2010). ANT understands controversies over e.g. statements or technologies and their settlement as translation, that is as a process of actors – human and non-human – attempting to translate their goals and views into new territory while having to adapt to or try to alter other actors' positions (Callon 1986; Latour 1987; 2005). Employing different translation strategies (Latour 1987, chapter 3), actors in ANT hold positions and try to affect their surroundings to pursue goals analogous to the negotiations and contestations characterising private governance processes.

ANT fits the research object – i.e. the technical character of the content of the TCFD controversies – particularly well. It is purpose-built for a technical context in which debates over the most suitable indicator, formula or the correct technical definition (Ascui, Haward, and Lovell 2018; Collins, Cowell, and Flynn 2009; Latour, Woolgar, and Salk 1986; Mol 2002) rather than controversies explicitly over the distribution of wealth, rights or responsibilities dominate. Such controversies are therefore not necessarily resolved through bargaining but through the fashioning of relations with and between objects and actors. A scientist, for instance, might convince a colleague of a statement by acting as a

spokesperson for something that cannot speak for itself such as a microbe (Latour 1987, chapter 2). Another feature specific to such technical debates that ANT highlights is that an increasingly technical and specialist conversation is not an indication for pure reason displacing political conflict but rather for an issue to be so contested that the actors involved keep mobilising more technical resources to ‘win’ (Latour 1987, chapter 1). This sensitivity of ANT to the particularities of technical controversies typical for transnational governance debates including debates around the best frameworks and indicators for climate-related disclosures allows to “stay with the trouble” (Law and Singleton 2013, 488) and thus trace controversies and interests further.

ANT also fits the research object well in that it understands relations as precarious and inherently fluid which matches the findings presented above on how interests and interest coalitions in governance are heterogeneous and unstable rather than monolithic blocs. Who acts, i.e. where agency lies, cannot be assumed ex-ante but is exactly the focus in an ANT inquiry. The formation of networks of actors which acquire agency by virtue of their connections is what ANT seeks to understand therefore enabling more forensic research of interests and actor coalitions (Latour 1987; 2005; Law and Singleton 2013).

This fitness of ANT to better understand governance processes has been demonstrated empirically in multiple contexts, often with a focus on the role of non-human actors (Ascui, Haward, and Lovell 2018; Collins, Cowell, and Flynn 2009; Rutland and Aylett 2008) but also explicitly to trace how controversies persist or are closed down, e.g. in the context of biodiversity governance (Scott et al. 2014). The identification of interests is a less common exercise in empirical ANT research. This might partly be due to the somewhat under-conceptualised nature of interests in the conceptual ANT literature. While interests in the form of an actor’s goals is central to ANT’s idea of translation as mentioned above, a lack of specification of the nature of such goals has lead critics to assume that ANT relies on a rationalist and atomistic conception of the individual and its interests (Lave 2015, 218–19; Roberts 2011, 49). However, (Latour 2005, 204–18) explicitly specifies how subjectivity is defined in a relational way and how the individual needs to be conceptualised as actor-network itself. Subjectivity is defined by a multitude of so-called plug-ins ‘downloaded’ into the individual from its surrounding. Interests are thus not independent from but constituted by an actor’s position in a network and their links to other actors, human and non-human, and their respective views and goals. To what degree such links defining an actor’s subjectivity enhance or inhibit their autonomy effectively depends on how well these ties align with the previously held goals suggesting that interests develop through cumulative ties.

In the context of private or hybrid governance, this means that an individual actor could be a highly autonomous actor, a mere agent of e.g. their employer, or adaptable and following rules of

appropriateness. Their goals could range from fully egoistic to altruistic. Hence, this open-ended, relational conception of interests and the self accommodates the full range of theoretical views within the governance literature (see Bulkeley et al. 2014, 41–42). In ANT, these highly diverse interests and their constitutions are conceptually identical as they are all constructed relationally and only differ empirically. The differentiation key to the argument of this paper is thus an empirical one as well: the differentiation between organisational interests, i.e. individuals on the task force representing the interests of their employer, and wider interests in the context of this paper called common good interests. These common good interests are typically formulated vaguely as e.g. ‘climate action’ or the ‘implementation of the Paris Agreement’. They can also relate to ideas of the common good not directly linked to the planet’s climate but to e.g. future generations. Other version of a common good relate to general economic or financial stability. Here, the boundaries between the enlightened self-interest of an organisation within such an economic or financial system and the common good become blurred thus limiting this study in that regard. Another caveat of this conception of common good interests is that it centres not the actual attainment of these goals but the expressed perception of individuals that their position advances said common good. As e.g. in carbon trading, virtuality and virtuosity can become conflated and what might be rightfully criticised as even harming the public good can appear virtuous in practice (Paterson and Stripple 2012). Thus, this paper – in the tradition of ANT (Venturini 2010) – takes the actor and their views seriously and understands common good interests as defined by individual conceptions of the common good. This makes the paper methodologically vulnerable to interviewees’ attempts to tell virtuous stories about themselves. An issue addressed in the following methods section.

3.4. Methods

Since the decision-making processes within the TCFD were closely guarded, only two data sources are available. First, the official final outputs of the TCFD, namely the final recommendations and two appendixes on scenario analysis and sector-specific guidance for implementation, are textual artefacts of the eventual consensus and signify the end point of the contestation process that is the subject of this study. While the TCFD continues its work up until today to specify their recommendations (see e.g. TCFD 2021b), this paper exclusively focuses on the development of the final recommendations published in summer 2017 (TCFD 2017a).

Second, process-related data, i.e. data on where and how contestations formed and were resolved, was collected through interviews with individuals involved in the development of the TCFD recommendations. These interviewees can be classified into individuals directly involved in the internal TCFD discussions and those indirectly involved. In the former group, 15 of the 32 members of the TCFD (abbreviated as TCFD where quotes are provided), six of the seven members of the TCFD Secretariat

(abbreviated as TCFD-Sec), and two representatives of financial regulators and supervisors (abbreviated as FR) were interviewed. The gender imbalance of interviewees with men outweighing women by a factor of two, mirrors the imbalance within the field. In the latter group, four more representatives of financial regulators and supervisors as well as two representatives each of consultancies (Con) and NGOs (NGO) were interviewed. These 31 interviews lasted an average of 54 minutes with a minimum length of 25 and a maximum length of 115 minutes.

The interviews were transcribed verbatim and coded inductively and empathetically (Willig 2014) employing thematic analysis (Braun and Clarke 2006). After coding, all codes which were only used on two or fewer transcripts were discarded. The remaining codes were categorised into issue specific codes and concept codes with the former organising the data according to topics that were discussed within the TCFD and the latter capturing dynamics or factors characterising how these topics were debated (see Table 4). Data on the seven topic areas thus identified were subsequently re-read to develop for each of them a detailed account of interests and contestations mentioned by interviewees. The code '4 pillars' was eventually dropped as no disagreements on this overall framework structuring the TCFD recommendations was recorded which highlights one of the boundaries of this study: Only contestations within the task force rather than conflicts over the substance of its discussions that could or should have erupted can be covered in this paper.

Issue specific codes	Conceptual codes
Scenarios. Accounts of scenario analysis or any of its components being discussed within the TCFD.	Beyond disclosure. Statements by actors on the purpose and impact of the work of the TCFD going beyond public disclosure.
Carbon intensity. Accounts of metrics measuring the so-called carbon intensity of investment portfolios being discussed within the TCFD.	Depoliticising. Accounts of attempts to keep elements perceived as political out of TCFD discussions.
Carbon foot-printing. Accounts of carbon foot-printing metrics, i.e. scope 1, 2, and/or 3 emissions being discussed within the TCFD.	Representation. Accounts of actors being seen as representatives of someone or something or of the absence of such a representative.
Litigation risk. Accounts of litigation risk being discussed within the TCFD.	Conflict lines. Accounts of disagreement and/or conflict within the TCFD.
Lobbying. Accounts of climate-related lobbying by companies being discussed within the TCFD.	Individual background. Accounts of the personal or professional background of interviewees.
Coverage. Accounts of what entities should be subjected to the TCFD's recommendations.	

4 pillars. Accounts of the four pillars framework structuring the TCFD recommendations, i.e. governance, strategy, risk management, and metrics & targets.

Table 4: coding framework

This methodological approach poses two main challenges that limit the study somewhat. First, the secretive nature of the TCFD's discussions and decision-making processes in combination with access issues meaning that only about half of the TCFD members could be interviewed makes triangulation difficult. To ensure some degree of reliability, only statements that were confirmed by one – for the first phase of the TCFD's work with fewer members than the eventual 32 – or two – for the main phase of the TCFD's work including all 32 members – other interviewees which had to belong to a different organisational sub-group. These sub-groups bundle together organisations with somewhat similar business models: TCFD members from resource-intensive companies such as ENI or Tata Steel, TCFD members from service providers such Moody's or the Big Four Accounting firms, TCFD members from investors such as banks, asset managers and insurance companies such as UBS or BlackRock, financial regulators and supervisors such as the FSB or the Bank of England, NGOs, consultancies, and members of the TCFD secretariat. This kind of triangulation mitigates – at least to a certain degree – sub-group-specific biases of views and perceptions. To further mitigate biases introduced by interviewees' storytelling efforts, during data analysis close attention was paid to potential indicators of such efforts: internal inconsistencies within an interviewee's account of their interests and their actions; affirmations by an interviewee to repeat their statement on their interests publicly; linguistic features suggesting a well-developed rather than a spontaneous account such as elaborate comparisons or idiom-like formulations. Interview sections characterised by such features had to be verified by at least two other data sources or they were dismissed.

A second challenge pertains to the anonymisation of interviewees and their organisations. Given that the main argument of this paper identifies individuals and their interests as relevant force shaping the TCFD recommendation, the evidence presented necessarily needs to contain information on the individual level and should ideally contrast individual interests with the interests of the organisation the respective individual represents. In many cases, this would make an identification of the individual and/or the organisation in question possible. The paper cannot fully resolve this fundamental methodological and research ethics dilemma. However, the following measures have been taken to ensure the anonymity of interviewees and their organisations while still providing direct evidence of core arguments to the reader: To ensure anonymity, only the sub-group category as per the above will be disclosed regarding an interviewee's organisational affiliation. The quotes presented are

anonymised in a far-reaching way. To still convey some of the richness and granularity of the interview data, this paper heavily relies on 3rd party quotes in its presentation of evidence, i.e. accounts of interviewees on statements or actions by other actors since such quotes allow a clear identification of the actor without revealing the identity of the interviewee.

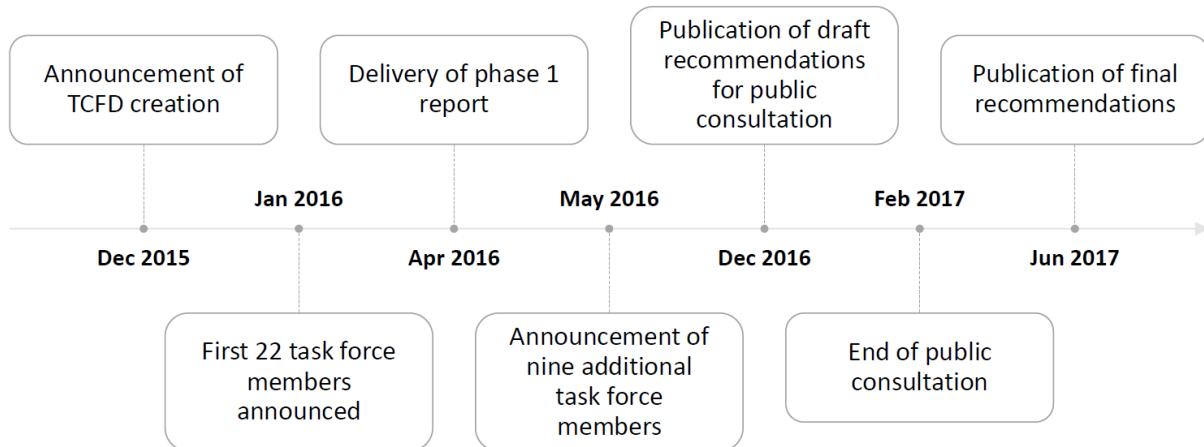


Figure 4: timeline of the TCFD process

3.5. Representation on the TCFD

Before dissecting the controversies perceived as most salient by interviewees and how interests became visible in said controversies, the type of organisations represented on the task force are mapped and the concept of representation in this context critically interrogated to further motivate a tracing of controversies focusing on individuals rather than organisations as relevant carrier of interests.

The membership of the TCFD – in terms of organisations represented – is the outcome of dual moves of both homogenisation and diversification. Homogeneity of the TCFD was pursued by excluding two wide groups of organisations. First, NGOs and academics were not allowed on the task force since it was feared they might harm the legitimacy of the whole endeavour by introducing interests into the task force discussions other than the business interest of managing climate risk.

"I think they [NGOs] would have potentially damaged the credibility of the task force. There was real concern by some people that it just wouldn't work to have these guys in the room. That's not to say that an awful lot of behind the scenes conversations didn't happen because they did, but I think it was seen as being... Just wasn't quite right that they would be in the room driving this because they had their own, they had their own particular axes to grind, Matthias. Whereas if it's in the investors in the room, the investors are there for a reason, to make better investment decisions. These green NGO out there who's interested in

whatever, that's not mainstream financial decision-making, this is about the threat to financial stability. It's not primarily about the threat to the environment.” – TCFD6, 25.04.2019

The TCFD was explicitly and constantly described as an initiative “for the market, by the market”⁵ (Carney 2016) invoking the idea of a market-internal democracy to ensure the TCFD would be perceived as legitimate by market actors.

And he [Mark Carney] was adamant that this was actually not NGO-based, that he wanted this to be done all with public [publicly traded] institutions, or ... You know, we're a private company, but we're involved in public markets. He was really ... felt that for this to take off, it could not be NGO-led.” – TCFD-Sec1, 31.01.2019

However, not all market actors were seen as possible members of the task force productively contributing to its work leading to the exclusion of a second group of actors which in the context of this paper will be called climate laggards as shorthand.

“They [the FSB] weren't going to pick members from again, I really don't want you to say like Exxon, who they know want to block this stuff, right? So they picked members who they thought would be constructive to the process rather than, than block it right? [...] Leaders and not laggards, right?” – TCFD3, 21.03.2019

This exclusion was – at least in some instances – self-imposed, however, since some companies which could be considered climate laggards did not want to join the TCFD when members were first recruited to not bestow the issue of climate change with heightened attention.

After these homogenising moves, the TCFD membership needed to be diversified, however, to convey the image of a group truly representing ‘the market’. All types of organisations with a business stake in the matter of climate-related disclosures had to be represented. These types have been labelled differently by the TCFD over the years but have fundamentally stayed the same: Data users captures the group of organisations called ‘investors’ in this paper, i.e. banks, asset managers, insurance companies etc. Data preparers refers to organisations primarily providing rather than using climate-related disclosure, i.e. corporations in the ‘real economy’ rather than financial institutions. Lastly, data service providers entail companies with a business model revolving around data analytics or assurance such as credit rating agencies, index providers or the auditing firms. This broad categorisation of organisation types to be represented in the TCFD both allows for and conveys a somewhat sector-

⁵ See also the TCFD website: <https://www.fsb-tcfd.org/support-tcfd/> [last checked 17.05.2022].

agnostic and a-geographical notion of markets aligned with the idea of global and borderless finance. A more specific or granular representation was not just not practical but it also was not considered necessary.

And you know, one of the things I'm always keen to emphasize is, do we have a wide geographic dispersion of members in the TCFD? Also across institutions? These are international firms. So you know, their headquarters may be in one country or another, but it's not like they are the representatives of their country or whatever. They're a group of multinational firms, preparers of information, users, accounting firms, circles coming together to address- to look at global disclosures that are used globally. So it's important to have that geographic dispersion but you know, when we're not- we're not assembling it rigidly by nationalities." –

FR5.2, 22.01.2020

Thus, representation and diversity had to primarily be achieved in regard to the idea of a global market without explicit geographies. Such an understanding of representation veils the non-representation of local or geography-specific market participants. For instance, not a single organisation based in Africa and not a single small or medium-sized company – despite their significant role in most economies and labour markets – was or is represented on the task force.

Thus, while a closer look at the recruitment of TCFD members reveals how some interests were excluded from the task force, it is not entirely clear which interests were indeed represented given vague references to 'the market' and the broad categorization of organisations into data users, preparers, and service providers. TCFD members from organisations within any of these categories would not even necessarily act as representative of their respective industry rendering the idea of representation of an even broader category of organisation rather abstract.

"So I kind of figured, well, I'm not going to be a mouthpiece for that company if that company wasn't prepared to stand up and speak for itself. So I would present my view cognizant of some of the discussions that happen in the industry. But I never felt like I had to represent the views of individual companies." – TCFD8,

25.07.2019

The question of representation becomes further complicated when considering individual TCFD members' organisational affiliations over time. One member, for instance, was employed by Mercer, a data service provider when first joining the task force while during her tenure moving to BNP Paribas, a globally active bank and thus a data user. One of the TCFD's co-chairs at the time of the development of the TCFD recommendations worked for the global insurance provider Axa but had a previous career

in central banking and lately joined a university as professor. These shifting career trajectories draw in question whether these two members be considered to exclusively represented the interests and views of the organisation type they are employed by at any point in time. The fragility of the idea of organisational representation trumping individual views and interests is further illustrated by the contrasting of two more TCFD members: While one relieved of his work duties at Daimler and consequently his TCFD role after information on animal testing of emission effects became public⁶, another TCFD member lost his seat in the TCFD because he left his employer Barclays and joined the NGO Carbon Tracker advocating for a low-carbon future. They later re-joined the TCFD when starting employment at BNP Paribas. It is not intuitively clear whether or how these two individuals should both be considered as equally merely representing the interests and views of two organisation types primarily differing in their relation to data – one being a preparer and one being a user.

The latter example does not only call into question the stability of the relation between an individual TCFD member and the organisation (type) they are seen to represent but also poses the wider question to what degree TCFD members actually represented ‘the market’ altogether. Not even the TCFD’s official *raison d’être*, i.e. the provision of information for markets to make better informed investment decisions (see e.g. TCFD 2017a), which has been heavily criticised in the academic literature as neoliberal governance naively relying on the efficient market hypothesis and other unrealistic assumptions on markets (Ameli et al. 2020; Ameli, Kothari, and Grubb 2021; Christophers 2017), was thought of as market-based by all TCFD members.

“So, disclosure, um, you know, is important. But it's only important because you have to build the governance, the strategy and risk management frameworks to enable you to disclose.” – TCFD3, 21.03.2019

“When you ask a company to make a disclosure, [interviewer’s name], as you understand, typically the audit committees get involved, the finance director gets involved therefore it's a main board issue, so as a way of getting climate risk onto the board agenda, this was a way of doing that.” – TCFD6, 25.04.2019

“So, it's not just about getting more information from corporates, but also about building the capacity in the financial institutions to actually interpret this in an equal way and incorporate this into investment decisions.” – TCFD1, 06.02.2019

⁶ <https://www.handelsblatt.com/unternehmen/industrie/affaere-um-tierversuche-auch-daimler-und-bmw-ziehen-konsequenzen/20911636.html> [last checked 17.05.2022].

“And the TCFD is a disclosure guide, but it hints and winks at how you would go about doing it.” – TCFD-Sec3, 01.06.2020

Hence, TCFD members did not understand their mission as limited to the provision of information to ‘the market’ but they intended to induce change in companies’ and investors’ organisational practices, i.e. changing rather than neutrally representing the market and intervening in rather than in a neoliberal fashion unleashing the market.

Thus, inferring what interests were represented on the TCFD by understanding task force members as representatives of their employer, of data users, preparers or service providers, or of ‘the market’ understood as the incarnation of a neoliberal mindset would neglect several layers of complexity illustrated above. Hence, instead of focusing on contestations along pre-conceived organisational lines, conflicts need to be understood as less organisationally defined, potentially emerging between individuals rather than (types of) organizations. While organisational representation did indeed play a role in conflicts on the surface of the TCFD process as in the constant quarrel between data users requesting more and more information from data preparers who in turn did not want to produce such additional disclosures, the contestations perceived as particularly heated and pivotal formed and unfolded along multiple shifting conflict lines.

TCFD6: “It wasn't obvious who would be fighting who sometimes. Sometimes you might get two people seemingly on the same side fighting each other.” //

Interviewer: “So it was not just [data] users and preparers?” // TCFD member 6:
“Oh no, dearly no, oh no, no.” – 25.04.2019

3.6. Contested disclosures

This section unpacks four situations – in a pragmatist sense (Bridge 2021) – of contestation consistently raised as both particularly controversial and significant by interviewees. In doing so, this section wants to illustrate two arguments novel to the literature on private governance: First, interest coalitions regularly shift from issue area to issue area rendering a firm and universal conception of boundaries between interest groups problematic. Second, in most conflict situations several individuals were driven by and sometimes realised altruistic values or values clearly going beyond the immediate material interests of their employer or type of organisation they seemingly represented thus making the individual in private governance an important carrier of interests.

3.6.1. Common good interests and disclosure conventions

At the very beginning of the task force’s work a small group of TCFD members from service provider and investor organisations attempted to widen the boundaries of what the TCFD recommendations were supposed to cover. In the first instance, this group of members argued for the disclosure

recommendations to apply not only to companies but also to asset owners and asset managers. Their rationale was that voluntary disclosure recommendations would not put sufficient pressure on companies to make difficult or uncomfortable disclosures. However, if large institutional investors required their investee companies to provide such information so that in turn they could disclose their climate-related information, additional pressure would be exerted on companies to actually comply with the TCFD recommendations.

“So a tough issue, was how to get... how to motivate corporate uptake in the absence of it being mandated. I always felt it should be... and I still continue to believe it needs to be mandated. But-but you know, I-investor engagement partly encouraging their supply chain to disclose. The mentality was and that will then encourage them to engage with the issues to get them to disclose, so that the disclosure is complete. That's a new concept.” – TCFD9, 06.01.2020

This initiative does not only demonstrate clear differences between a market-naïve neoliberal mindset and the actual ideas and strategies of TCFD members, but it also illustrates how some members were concerned with the transformative impact of their recommendations and the speed at which such impacts would materialise, clearly motivated by the urgency of the issue.

The group's attempt was met by resistance not primarily from other TCFD members – partly because at this early stage not all members had joined the task force yet – but from the TCFD Secretariat echoing findings by Pelger (2016) on the agency of technical staff. Primarily staffed with US American experts on financial regulation led by Mary Shapiro, the former chair of the US Securities and Exchange Commission, the TCFD Secretariat in many ways embodied the thinking of financial regulation and supervision of its host, the FSB.

“Basically, [TCFD Secretariat members] are all a bunch of regulators over at Promontory [Mary Shapiro's consulting business]. [They] knew how to be very specific, [they] knew how to write for the FSB, also, you know, Mary used to sit on the FSB.” – TCFD-Sec3, 01.06.2020

One of its primary missions was to ensure the TCFD recommendations would be well received by the FSB. Hence, risking an extension of what the TCFD should cover potentially perceived as transgression of the TCFD's mandate was seen critically by the Secretariat.

“So I think for me the most important decision that was made in the first wave, which was really my kind of axe to grind, was that we should make the recommendations go beyond our mandate, which was really focused on

companies and apply to the investment community. And there were, it just was not an obvious extension of our mandate to many people. So I had to do a lot of convincing [...] It was convincing, partly convincing the secretariat to be honest.

Like Stacey and Didem who were really interpreting the FSB guidance, right, because they're very, like, they're policymakers. So they're policymakers. So "Our mandate says this, right?"" – TCFD5, 18.04.2019

Eventually, the conflict was resolved in favour of the TCFD members by extending the conception of an investor. While investing in accounting is typically conceived as a professional activity conducted through and by organisations dedicated to this purpose such as investment banks or asset managers, the TCFD broke with this convention of providing information to such professional investors only and considered end savers as relevant users of information, too.

"In particular, the Task Force believes that asset managers and asset owners, including public- and private-sector pension plans, endowments, and foundations, should implement its recommendations so that their clients and beneficiaries may better understand the performance of their assets, consider the risks of their investments, and make more informed investment choices." (TCFD 2017a, 17)

Of course, such a conception of the users of financial disclosures is still limited, ignoring potentially different information needs of e.g. employees or tax authorities. It was sufficient, however, to ensure agreement over the question of who the TCFD recommendations should apply to.

Further revealing the common good interests of the TCFD members involved in this extension, they all expressed a strong support for disclosure mandates given the failure of their plan to let institutional investors indirectly enforce the disclosure recommendations by pulling the information out of corporates through the investment chain.

"And very few pension funds have actually said we're going to do it therefore we need the relevant information, so the concept of the investment chain, and you know, the pulling on the investment chain, great in theory, just hasn't happened with a degree of energy and urgency that we need. You know, I said don't trust the, if you trust the boards... And I'm really worried about the journey to four degrees and what that will mean for my DC, my young DC members, and this has to be a mechanism that could potentially change the path towards four degrees. And we, we are running out of time. And things like Extinction Rebellion and Greta

Thunberg." – TCFD6, 25.04.2019

Another attempt to push the boundaries of the TCFD recommendations aimed at including an additional corporate activity: climate-related lobbying.

TCFD5: "The other kind of controversial things were one, we weren't allowed to, we weren't successful about getting anything in there about lobbying. So some of us wanted the recommendation..." // Interviewer: "Lobbying disclosure?" // TCFD5: "Yeah. We were just told that it was a no-go zone. // Interviewer: "From the secretariat?" // TCFD5: "Yeah. And the FSB." // Interviewer: "Okay. Okay." // TCFD5: "It was going to be too political." – 18.04.2019

While the disclosure of climate-related lobbying activities is more likely to go against the interests of resource-intensive companies rather than investor organisations, investors' climate-related lobbying has come under attack as well making investors not an obvious proponent of lobbying disclosure. However, some investors could conceive lobbying activity as a material risk factor thus making the push for integrating lobbying into the recommendations an organisational interest. One of the most active proponents of integrating lobbying, however, at the time worked for a service provider with no such interests. At least for them, lobbying disclosure could be a potent mechanism to discipline companies into aligning their lobbying activities with the general public's norms around climate change.

The lobbying proposal and its rejection is not only another instance of common good interests beyond represented organisations' interests 'leaking' into the TCFD's work via individuals. It also illustrates the limits set to TCFD's work but also climate risk regulation and supervision in general by the accounting convention of considering the firm's boundaries as the boundaries for risk disclosure and management – a convention that in the past has notoriously contributed to the neglect of risk contagion and cascades leading up to the financial crisis of 2008 (Power 2009). The entity- rather than system-focused conception of risk disclosure made it possible to consider climate-related lobbying disclosure to lie outside of the TCFD's remit.

"Because the spending on lobbying or whatever amount of money is spent on lobbying. That, you know, once that's done, then it has a separate impact that ultimately maybe coming- coming back to the company, but it's just a little bit more removed from the company's actual activities and the actual risks and opportunities that it faces. [...] If you're successful with lobbying around climate issues, ideally, we're going to be reducing physical impacts of climate change over time, which ultimately is better for the company. But it's just, it's a big circle to be making, and we need to stay so focused within the TCFD's remit on things that are

kind of material and clear today. It just didn't rise to that level." – TCFD-Sec5,

26.06.2020

3.6.2. Systemic perspectives and Mark Carney

The human-made, rapidly progressing climate change the planet has been experiencing since the industrialisation is inextricably linked to greenhouse gases as the driver of rising surface temperatures. It might therefore not be surprising that the TCFD recommendations contain advice on disclosing "Scope 1, Scope 2, and, if appropriate, Scope 3 greenhouse gas (GHG) emissions" (TCFD 2017a, 14) and – for investors – the "weighted average carbon intensity" (TCFD 2017a, 36) of investment portfolios. However, both of these disclosure items were intensely contested and their inclusion into the final recommendations had to be enforced by an actor not even officially part of the TCFD: Mark Carney.

In the case of weighted average carbon intensity (WACI), the conflict line ran through the investor group and could be interpreted as separating early implementors which had already gained experience with using carbon intensity metrics and those which had not. However, this conflict line in fact both within the task force and later during consultation with other investor organisations was rather defined by diverging views on the question of whether WACI was actually a risk indicator. Implementation costs which were used as argument in multiple other debates were not mentioned by any interviewees.

"The metrics that we do have pushback on, is the carbon footprint for financial institutions, because a lot of them [investors] feel like it doesn't accurately represent climate risk, which is true in part. You know, for a portfolio, knowing the carbon footprint doesn't necessarily tell you if the company is ... are transitioning, or where there are opportunities, but we feel like there's not necessarily a better metric out there right now that is better." – TCFD-Sec1, 31.01.2019

This was indeed a genuine concern for some investor organisation. With no widely accepted body of evidence or practitioner consensus, the question of whether WACI was a risk indicator or not was thus in a deadlock until Mark Carney expressed strong support for it.

"Carbon intensity for investors, that was a bit controversial. That was a Mark Carney... He likes that, we just gave up on that and said, he can have that. [...] I remember phoning my chief investment officer [name], 'I need, I need you to just tell me if this, if it's carbon foot-printing and it's using the mathematical basis that Carney would like, would we do it?' 'Yeah ok but I don't think it's useful.' 'Oh no, I know but will we do it?' 'Yes, okay.' Right well we- just agreed." – TCFD6,

25.04.2019

However, some interview data suggests that opposition to WACI was also partly motivated by the concern of publicly disclosing indicators which could not be fully controlled by asset managers while at the same time potentially exposing an investor organisation to public backlash.

"Yeah, well I think the asset managers sometimes said that it's useless information, um, because we cannot really influence it because our clients choose their, um, their, they, they choose the way they, um, they structure their portfolio. So we don't feel comfortable publishing these figures because we have no control over the actual outcome. [...] I think it was just, just a general discomfort because the, the feeling was that if you would publish this data, it could become very political." – TCFD7, 06.06.2019

Thus, resistance against WACI simultaneously formed around technical arguments of usefulness and political concerns around accountability of individual investment organisations. The outcome of this conflict, however, as mentioned above is not a function of early adopters within the TCFD convincing or overpowering resistant investors but rather the effect of the personal intervention of one single individual motivated by the interest of assessing and ensuring the health and stability of the financial system rather than of individual financial institutions embodying the shift in regulatory thinking towards a systemic perspective after the financial crisis of 2008.

"And it was, it was very much Mark Carney himself who came to the group and said, look, this is important. Um, you know, we, as, as, as regulators of the system need that kind of aggregate data to understand potential build-ups of stranded assets. If you guys won't publish that, we won't, will be much more difficult for us to, to, to get, uh, some type of visibility on, on concentrations of potentially stranded assets." – TCFD7, 06.06.2019

The emphasis on Carney personally intervening made by many interviewees as well as the lack of any accounts of other FSB or FSB member representatives being involved – either directly or indirectly – into this controversy again highlights the need to take individuals seriously as relevant actors and carriers of interest. No other formal representative of regulatory interests felt the need to intervene or to support Carney indicating that the strong support for WACI was not necessarily a consensual regulatory interest but – at least to a certain degree – an individual's conception of regulatory interest.

In the case of carbon foot-printing a similar conflict situation unfolded with different self-interests standing against more common good and system-oriented interests eventually successfully realised again by Mark Carney.

TCFD member 5: "The other super-controversial thing was the carbon foot-printing recommendation. There was so much pushback from a bunch of the big investors on the TCFD who didn't want to have the carbon foot-printing recommendations. So the metric that says, disclose, scope 1 and 2, and if appropriate, scope 3 GHG emissions and the related risks. So the footnote to that recommendation is bigger than the actual recommendation." [see TCFD (2017a, 22)] // Interviewer: "Yeah yeah yeah, I've seen it." // TCFD member 5: "Yeah, and it so, you know, it's Carney who insisted on that recommendation." // Interviewer: "He intervened personally?" // TCFD member 5: "He personally intervened, yes." // Interviewer: "So he made it happen." // TCFD member 5: "He forced it. Because BlackRock, UBS, even Generation didn't want it. They didn't think it was the right metric, or that instructive. [...] So he [Carney] intervened and said that, you know, his view was it was an essential element to underpin the credibility of the recommendations. It fell into the kind of useful information category that was going to help to, basically, help to prevent the systemic nature of the risk." –

18.04.2019

This quote highlights two key characteristics of the carbon foot-printing controversy: First, individual representation of wider, i.e. system-focused, interests was highly relevant in shaping the eventual TCFD recommendations. Second, resistance against carbon foot-printing cannot exclusively be explained by organisation-specific interests with investor organisation without significant carbon foot prints themselves, even one with an explicitly environmentally focused mission such as Generation Investment co-founded by former US vice president Al Gore, speaking out against this metric based on – again – concerns around whether this metric does in fact capture climate risk.

The eventual version of the carbon foot-printing recommendation is a compromise between positions, however, and not simply win for the advocates and for Mark Carney. The arguments brought against carbon foot-printing in general were even more pronounced and eventually successful against the disclosure of scope 3 emissions, i.e. emissions resulting from the products sold by organisation in question. First, the feasibility of collecting scope 3 emission data was questioned.

"So I would say those are the two main arguments number one that that, you know, it's too difficult to get the data, which, in any case, of course, of course, there are difficulties, but if, if, if we didn't do anything, because it was too difficult, we wouldn't have progressed from the Stone Age, you know." – TCFD13,

27.04.2020

Second, whether scope 3 was indeed a relevant risk indicator was drawn into question in multiple ways.

“And recurred for a long time throughout the time we were discussing for the original report was, what is the mandate of the TCFD? Is it there to look at how companies are, are impacting the environment or is it there to measure how vulnerable companies are to changes in the environment? And that was one of the arguments used now I think of it by the people who were not keen on scope three emissions, because they say, well, what's the value of this information? It's not going to tell you how vulnerable these companies are to changes.” – TCFD13,

27.04.2020

Proponents of such arguments as in this case a representative of an emission-intensive organisation remained so and only gave up their position due to Carney's intervention.

“And the thing about carbon foot-printing that worries me is it's a very simplistic measure for saying the way you reduce your climate risk in your portfolio is to divest fossil fuel players. But yeah, you can do that, but do you actually mitigate climate risk if you do that? [...] So the risk is still there, but it's also the other risks are not identified and managed. So this issue about, you know, for example, coastal real estate for example, like there are so many pervasive climate risks that companies are exposed to and this carbon foot-printing metric effectively I think quarantines risk to a certain sector and doesn't talk about all the other areas that also need to be part of the solution. [...] And also I think largely it comes down to a view that climate risk is only a risk that needs to be managed in the fossil fuel industry. So it's both about simplicity of metric and it's about quarantining the risk to a particular industry. [...] I was basically told we can't not include it because Carney has said that he wants it. And I was like, ‘Well fair enough.’” – TCFD8,

25.07.2019

This line of argumentation was perceived as line of defence by emission-intensive companies even by some task force members.

“And so for me, the idea that anybody could say, ‘What practical use do you think this information will be?’ I found it quite astonishing, because you need to know what the impact of these companies is, if you are, if you're going to be able to make a meaningful judgment on the impact they're having on the environment, and therefore on how we should be thinking about them as a winner or a loser in

a two degree carbon constrained world. [...] I just found that astonishing. But you know, it kind of blended into this idea of oh, it's not really the company's responsibility. So it's unfair to put the onus on them to report, it is the customers and, you know, BP in particular, but other oil companies has been hiding behind that line for a long time, you know, so I felt it was also legitimising their obfuscation.” – TCFD13, 27.04.2020

To sum up, despite the intuitively natural choice by the TCFD to include carbon foot-printing and carbon intensity metrics as key elements into their final recommendations, these two issues were highly contested. While the material interests of emission-intensive organisations can explain some of the resistance against these metrics two other factors as illustrated above are pivotal to understand the contestation and the eventual outcome fully: First, the level on which contestations were articulated was strictly technical in the sense that the metrics in question were tried to be pushed outside of the remits of the task force by constructing them as irrelevant or even counterproductive for the purpose of climate risk management. This technical nature of the contestation allowed investor organisations with no emission-related self-interests to position themselves in this debate. Second, Mark Carney's personal intervention based on his individual conception of systemic risk and related regulatory interests ensured the inclusion of both carbon foot-printing and WACI into the TCFD recommendations highlighting again the relevance of individuals as carriers of interests in private governance.

3.6.3. Climate scenarios and the Paris Agreement

While interviewees generally agreed that the TCFD recommendations were largely an organised collection of existing practices they also emphasized one element as genuinely innovative: scenario analysis. In its technical supplement, the TCFD characterises climate scenario analysis as follows:

“The purpose of scenario analysis is to consider and better understand how a business might perform under different future states (i.e., its resiliency/robustness). In the case of climate change, climate-related scenarios allow an organization to explore and develop an understanding of how the physical and transition risks and opportunities of climate change might plausibly impact the business over time. Scenario analysis, therefore, evaluates a range of hypothetical outcomes by considering a variety of alternative plausible future states (scenarios) under a given set of assumptions and constraints.” (TCFD 2017b, 2)

The innovative nature of scenario analysis lies in its forward-looking nature potentially going far beyond typical time horizons restricted by business cycles. In this sense, scenario analysis is the only element within the TCFD recommendations directly addressing what Carney identified as the key issue regarding climate change and finance: the tragedy of the (time) horizon (Carney 2015).

The novel nature of scenario analysis, its direct challenge for long established practices in business and financial management meant – unsurprisingly – that the inclusion of scenario analysis into the TCFD recommendations was an intensely debated issue. While there was hardly any disagreement on the idea that scenario analysis is a useful tool, the contestation revolved around how prescriptive the TCFD should be in its recommendations. Given the focus of this paper on interest constellations and outputs in private governance, this section will not cover all dimensions of these contestations but rather one aspect which reveals the value of accounting for individuals as carrier rather than organisational representative of interests: the question of recommending a 2°C scenario.

After scenario analysis had been established as a tool worthwhile recommending, a small group of individuals including an investor organisation and a service provider understood this as opportunity to require organisations to work on and disclose their alignment with a 2°C scenario as one of the consultants involved in early discussions recalls:

“I think when, when we first started discussing with the group, the brief was a little bit different, it was okay, [name of the consultancy], we want you to come in and help us define what is a two degree aligned scenario. And I think so it maybe, maybe was just in the minds of that sort of subgroup of organizations or subgroup of members, rather, who were driving this, that they thought what was initially needed was a two degree scenario against which organizations would, you know, would analyze their strategic plans.” – Consultancy5, 13.03.2020

This original intent, i.e. turning the TCFD recommendations into a vehicle to incentivize alignment with a specific climate goal, did not come to fruition as one of the TCFD members involved summarised.

“But the, so the fundamental difference from going to say, okay, just saying, if it [a 2°C scenario] happens, what would it do to you, to saying, we want to align with the scenario is a huge gap, right? And that if you look at the makeup of the TCFD, it's brought a little bit broader base. And as a consequence more conservative. So this is the more conservative approach. This is the lowest bar.” – TCFD5, 18.04.2019

While resistance against recommending climate alignment did come from a variety of actors and organisation types within the task force, the TCFD Secretariat itself which was concerned about losing FSB support had a firm and non-negotiable stance on this issue.

"I'm think first and foremost, there was a clear preference among some members of the TCFD being more of an advocacy body. This was during the time that Paris had happened, and there was a feeling that the even Paris Agreement was not going far enough. And that the private sector had to get very involved in helping drive change in saving Paris. [...] And the [TCFD] secretariat at the direction of, you know, the senior steering team, do you think was pretty clear: 'No, we don't, we're not going there.' But it was an ongoing issue throughout the late- during the time

I was on." – TCFD11, 05.03.2020

Thus, while the goal of incentivising alignment with a climate goal was not met, the TCFD recommendations still reference a 2°C scenario prominently in its 11 core recommendations: "Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario" (TCFD 2017a, 14). The group of TCFD members with the common good interest of turning the TCFD recommendations into a catalyst for climate action kept arguing for such a reference ultimately succeeding not based on technical arguments or negotiations but rather due to the discursive power the Paris Agreement and its 2°C goal had at the time.

"Yeah, so that [the 2°C scenario] was a shorthand way of referring to the ambitions of the Paris Agreement, without necessarily writing the Paris Agreement. And I think that's ... so it's ... I think it would be difficult not to have a reference to a successful climate policy outcome" – TCFD1, 06.02.2019

"At the time in 2016, and 2017 when that language was developed I think we took it took the language right out of the Paris Agreement, which says, two degrees or lower. [...] The reason that language specifically showed up in the 2017 was, was to anchor it to the Paris Agreement, the only, the only example of an internationally coordinated policy goal at that time." – TCFD-Sec4, 11.06.2020

"Well, because, it's, if we ever want to, from my perspective, it [the 2°C scenario reference] was around trying to push for people to be uh acknowledging that a two degree pathway is the pathway. That's not widely agreed within the business or investment community. Or it's certainly not widely understood. And perhaps it's improbable, but to do this kind of work and to come up with a set of

recommendations, that didn't have some reference to Paris and some aim to calculate the impact of achieving the Paris agreement, which at this time was also really fresh, would have been a huge failure. So there were you know a number of us that were really worried about that and really advocating to make that happen. At the same time, there were people who were rightly challenging how possible it is to do that, how realistic it is, right? But it was one of the areas where you know we prevailed because there was this acknowledgment that it was kind of a minimum acceptable level of ambition.” – TCFD5, 18.04.2019

Thus, the existence of the Paris Agreement and its reference to a 2°C or lower scenario legitimised its inclusion into the TCFD recommendations despite multiple challenges which – in short – revolved around two key points: First, is a 2°C scenario plausible and thus worth strategizing for? Second, is a 2°C scenario a relevant risk scenario? Especially the latter point is relevant as the challenge of relevance led to the exclusion of more specific scenarios from the TCFD recommendations.

“So you want to have a scenario that talks to your business and effectively what you want to understand is you want to create a scenario which tests the assumptions that you have and pulls particular levers and gives you an indication that if this particular thing was to occur, you'd be able to identify it and you'd be able to respond to coordinate to maximize value or minimize loss. That's basically what you want. And so to sort of say, well, we'll all use the IEA scenario, it's like, well how on earth is a shoe manufacturer in Bangladesh supposed to take a global energy scenario and translate it into something meaningful?” – TCFD8,

25.07.2019

In fact, the argument of specific, global scenarios not being relevant enough to a wide range of companies resisted the constant and strong pressure by investment organisations for a single standardised scenario to allow for comparability and easier analysis across assets.

“So, a lot of investors felt that for comparability's sake, it would be helpful to push everyone to do one market standard scenario. A lot of the companies said, 'That's just not realistic. It's not possible for our company. There isn't one scenario that fits.'” – TCFD-Sec1, 31.01.2019

“So what the, the financial players around the table would say is we need to create one scenario, right? And it's like a black box and you put all your numbers in and then you turn the handle and out pops a number, which is like a proxy for risk. [...] Um, but, but what, what the investors wanted was a really simple way of

comparing companies and the reality is I don't think you can do that in a way that actually represents the range of risks or the resilience of an organization to climate change related impacts.” – TCFD8, 25.07.2019

Further underlining the importance of the discursive power of the Paris Agreement justifying the demand for referencing a 2°C scenario and thus the importance of moral reasoning within the task force is the failure of the attempt to reference a 4°C scenario. From a climate risk perspective, if a 2°C scenario marks the far end of possible transition risk materialising, a 4°C scenario would mark the far end of the physical risk spectrum. Especially insurance companies, naturally expressing their interest in managing the physical risks particularly relevant to their core business, advocated for recommending the use of such a high physical risk scenario. Such attempts were met with – at least partly – morally motivated resistance.

“So, we asked for scenarios and then, I think based on the draft, so some oil and gas companies presented scenario analysis, right, saying as one of these scenarios in a four degree world for us it would be business as usual. And we would, we would grow with average of 4% per year, you know, and you know, TCFD members got crazy about that. They- or mad, I should say, right? They really got mad. And you know, this can't be! How can an oil and gas company say that?” –

TCFD15, 01.02.2021

“The insurance industry think they can model and disclose four degrees scenarios, I particularly didn't like that. Two reasons which is um, that I'm not at all convinced that the exogenous environmental factors don't simply swamp company cash flow specific model, and that's obviously a increasing level of uncertainty around what those environmental impacts are. And secondly after genuine concern about just, desensitizing people, sensitizing people to four degrees just being, I don't know, just a little bit more than two [degrees] [...]. That's why the task force did not specify four degree scenario, but put some language in around, you know appropriate for some industries.” – TCFD6,

25.04.2019

Thus, the controversies around recommending specific scenarios were partly defined by organisation-specific conflict lines of investors pushing for solutions allowing for comparability and insurance companies promoting high physical risk scenarios. The eventual output of the TCFD can only be explained, however, by accounting for individual members' common good interests which drove them

to oppose the recommendation of a 4°C scenario and to advocate for a 2°C scenario in the hope to facilitate the pursuit of the Paris Agreement's temperature goal.

3.6.4. Litigation risk and geographic fault lines

The significance of individuals' common good interests and the fluidity of conflict lines characterised contestations around key issues within the TCFD from scenario analysis to carbon-related metrics and the scope of the TCFD recommendations. However, a more traditional fault line along a well-understood boundary between organisations remained decisive in some areas of debate and shaped the final output of the TCFD significantly: geography. More specifically, the context US organisations operated made certain recommendations other TCFD members advocated for a threat to them. No other geographic fault line than the one between the US and the rest of the world was confirmed and emphasized as relevant so consistently throughout interviews.

While a range of factors shaping US organisations' stances on key issues were mentioned by interviewees, the effect of the US legal system creating a highly litigious environment was the only one highlighted repeatedly by both US and non-US interviewees. The fear of litigation has already been found to be a significant barrier to the adoption of other voluntary environment-related standards in the US (Delmas 2000; Delmas and Montes-Sancho 2011). In the context of the TCFD it fuelled resistance by US organisations against two core elements of the TCFD recommendations: First, disclosing climate-related information in official financial filings subject to a range of regulatory requirements implying a high degree of legal responsibility for said disclosures. Second, requiring all organisations to conduct scenario analysis in a quantitative manner. Both recommendations alarmed representatives of US organisations for similar reasons.

"So someone once described to me if they were going to do a scenario analysis, for example, I described the way our analysis process work because that's one of the issues we've got most stuff on. [...] one of the US companies said to me, 'If we were going to be doing the two degree scenario analysis and putting information in the public domain, the first person who would go to would be the general counsel. And we would say, how much information can we disclose? And the general counsel would say, none.' So the work would just never get done. Well, we'd never get disclosed because of this much more sort of reticent feeling around disclosure because of the litigious environment that they operate in. [...] Um, I also think this litigation risk manifested itself around the scenario analysis recommendation. So you'd have a lots of caveats around the way that work could be done. It could be qualitative, it could be minimal, you know." – TCFD8,

Concerns around such disclosures exposing an organisation to litigation were not only discussed in the abstract but some TCFD members concretised them clearly as in the case of potential mismatches between asset impairment figures disclosed in financial filings and scenario analysis assumptions.

"Here's what my revenues look like, here's a bunch of different scenarios, if I move to a two degree world, if I move halfway to a two degree world, if I decide not to go to a two degree world, and a bunch of different scenarios, here's my cash flows. I'm going to discount those back and compare those to my balances on my financial statements. Maybe I'm sitting on some coal reserves, and that analysis is going to tell me that those assets are eventually going to be impaired. So they were there in all, I don't mean this negatively, but they were very proud of their scenario analysis. So I raised my hand, and I said, So how does this match your impairment analysis of those same assets at 12/31/19 [date at the end of the financial year]? Are they the same assumptions? [TCFD member] said, 'Oh, I don't know.' 'So what do you mean, you don't know?' [They're] 'Well, I'm in the ESG group. And that's a controller of the CFOs group.' 'I understand that. But you're out.' I said, 'Who have you showed this scenario analysis to?' 'So we've shown it to, you know, stakeholders.' And I'm saying, 'so you shared this information with people that says, in 10 years, if you don't do anything, your reserves are going to be impaired? It is not my job, but I do think there's a risk that you're sharing information that could be contrary to information that you're using to pose your financial reports. And you publicly share this information?'" – TCFD12, 07.04.2020

Hence, the final recommendations around scenario analysis accommodate a wide range of approaches and do not require all organisations to fully disclose a quantitative scenario analysis – or to conduct scenario analysis at all but rather to 'consider' it.

The Task Force believes that all organizations exposed to climate-related risks should consider (1) using scenario analysis to help inform their strategic and financial planning processes and (2) disclosing how resilient their strategies are to a range of plausible climate-related scenarios. The Task Force recognizes that, for many organizations, scenario analysis is or would be a largely qualitative exercise.

(TCFD 2017a, 27)

Similar concerns arose for US Americans around the question whether all climate-related information should be recommended to be disclosed in an organisation's official financial filings.

"Interviewer: Was it also, um, opening the door to not disclose in 10-K [US financial filings document] when financial reporting or was that just because the US members were afraid of putting anything in a 10-K report? // TCFD member 8: Yeah, the US members were really afraid. // Matthias: Okay. // TCFD member 8: Yeah. So we couldn't mandate where we thought the disclosure should go because we knew that that would stop people from doing it. So we had to say, 'We want to see disclosure in financial filings, but you might choose to do it in other places as well or instead.'"

The litigious US environment meant that US organisations understood disclosure as compliance exercise and the provision of any information beyond the legally required threshold as unnecessary risk.

"But they [companies] are guided by enacted rules, especially when we talk to the US and as an American, I can say this. If the SEC says, I have to do it, I have to do it. If the SEC says, I don't have to do it, I'm not going to do it. Why am I going to put myself at more risk? Right?" – TCFD12, 07.04.2020

"And there's liability risk for some, particularly for Americans with corporate reporting and putting disclosures in their 10-Ks. [...] So there has to be an element of pragmatism, trying to get people on board and not turning them off so they never come on board. If you get them on board then of course, you're significantly increasing the chance of actually make the journey you want." –

TCFD6, 25.04.2019

Thus, again to gain traction for the TCFD recommendations within the largest financial market, the US, the final document had to accommodate US fears around possible litigation. The final formulation of the recommendations thus require organisations to disclose process-related information about the governance and the procedures of risk management in place within an organisation. It does not require organisations to disclose any actual content, i.e. strategic implications from climate risk analysis or any more concrete metrics or targets.

For disclosures related to the Strategy and Metrics and Targets recommendations, the Task Force believes organizations should provide such information in annual financial filings when the information is deemed material. Certain organizations—those in the four non-financial groups that have more than one billion USDE in annual revenue—should consider disclosing information related to these

recommendations in other reports when the information is not deemed material and not included in financial filings. (TCFD 2017a, 34)

Thus, whether an organisation needs to disclose substantive rather than process-oriented information regarding climate risk depends on a materiality assessment which in turns leave organisations a tremendous amount of manoeuvring space to eventually decided autonomously what to disclose in their audited and regulated financial filings.

The TCFD recommendations are hence neither the output of negotiations between self-interested company representatives nor of purely technical debates amongst neutral experts or an inevitable neoliberal consensus. They are rather a temporary consensus among individuals with vastly different interest configurations and varying degrees of autonomy versus representational constraints. This consensus does not pertain to every element of the recommendations but to the document as a whole and is only achieved at the costs of abandoning positions which could be perceived as political, i.e. as lying outside of the norms of the status quo, similar to the summary for policy makers documents issued by the IPCC (see Pryck 2021).

3.7. Discussion

The development of the TCFD recommendations was not just the drafting of voluntary disclosure guidelines. It constituted a pivotal moment in the construction of climate risk, in the ongoing process of concretising this abstract concept which was suddenly elevated to the heights of board rooms and financial supervision in and around the year 2015. This newly gained importance of climate risk as central frame for understanding how finance and the planet's climate are linked (see e.g. Christophers 2019; Langley and Morris 2020) – see for instance the private finance strategy for the most recent climate COP26 in Glasgow principally built around the concept of climate risk (Carney 2020) – makes a close examination and critique of its construction crucial for social science in the Anthropocene (see e.g. Lövbrand et al. 2015). ANT, however, which provides the methodological and conceptual basis for this study with its attention to detail, its radical empiricism, and its flat ontology, has often been rejected as suitable for facilitating critique (Koddenbrock 2014; Lave 2015; Mills 2018). This paper offers an alternative and practical rather than theoretical perspective on how ANT can serve as the basis for a more surgical critique of the TCFD.

First, this paper's findings on the presence and relevance of individuals' common good interests and the fluidity of interest coalitions shifts the focus away from organisational representation and the make-up of the TCFD and puts the argumentative unfolding of contestations into the spotlight. Rather than explaining certain aspects of governance outputs with the absence or presence of certain (types

of) actors in a governance initiative (e.g. McCarthy 2012; Silva-Castañeda 2012), this paper draws attention to how activist voices which were in fact present on the task force were shut down or forced to make concessions. This challenges the common analytical practice in literature on private governance to conceptualise substantial representation as organisational affiliation, locating interests exclusively at the organisational rather than the individual level (Dingwerth 2008; Pattberg 2017; Ruggie 2018) – independent of the highly diverse theoretical frameworks employed in the governance literature (e.g. Grabs, Auld, and Cashore 2020).

This contribution to the private governance literature on the relevance of individuals as carriers of interests emancipated from their employers' interests needs to be qualified, however. While comparative analyses would be necessary for verification, it seems plausible that some characteristics of the TCFD made it easier for individual members to represent common good interests rather than organisational interests: In terms of the TCFD's modus operandi, its small and secretive nature created a sense of trust and openness within the TCFD (see also paper 1 in this thesis) – similar to elite clubs Tsingu (see Tsingou 2015) – potentially more conducive to making individuals feel comfortable and safe to voice more personal concerns and ideas. This differentiates the TCFD from e.g. MSIs such as the FSC often emphasizing transparency or larger standard setting bodies such as the ISO. In terms of its membership, the individuals standing out as representing common good interest were all highly mobile elites which could afford and indeed often did pursue their further careers outside of the organisation they were formally affiliated with. Equally, they tended to have strong values and views on climate change. This might differ in e.g. expert bodies where e.g. professional values outweigh issue specific values (see e.g. paper 3 in this thesis). In terms of representational design, the TCFD was never meant to represent every organisation affected by the governance initiative unlike many MSIs where all stakeholders e.g. along a value chain or sought to be represented. Thus, by design the link between TCFD members and their respective organisations was weakened as they were expected to represent certain types of practical expertise – similar to expert bodies (see Owens 2012) – and 'the market' as a whole rather than individual organisations.

Returning to the issue of critique, serious attention to the role of individuals in developing governance outputs allows to empirically identify the barriers to common good interest represented in the governance initiative becoming enshrined in outputs. In the case of the TCFD, it highlights the role of legal structures in shaping the TCFD recommendations: More ambitious disclosure requirements around scenario analysis and the location of disclosures had to be abandoned due to the domestic legal environment US organisations operate in. Furthermore, even the seemingly most basic and intuitive climate-related metrics to disclose – carbon footprints and WACI – could be strongly and nearly successfully opposed by referencing the narrow conception of risk constituting the legal basis

of the FSB's and therefore the TCFD's mandate. These insights specify our understanding of how the global financial governance architecture is not set up for the goal of preserving life on earth but for ensuring the stability of the financial system and thus for risk control pointing to the wider role of legal codes in stabilising capitalist norms and distributional preferences (Pistor 2020).

Legal mandates are always open to re-interpretation, however. Just like systemic risk experienced a renaissance after the 2008 financial crisis within the supervisory community (Mackintosh 2017), FSB as well as TCFD members could revise their conception of risk and thus their mandate to, for instance, consider financial stability to be dependent on climatic stability which could therefore become a goal for financial supervision (Bolton et al. 2020). Such interventions into the interpretation of legal mandates and remits cannot easily be derived from a critique focused on the membership and organisational makeup of the TCFD or on the use and implementation of disclosure frameworks (as provided by e.g. Ameli et al. 2020; Ameli, Kothari, and Grubb 2021; Bingler et al. 2022; Christophers 2017). Thus, by revealing the relevance of barriers set to more ambitious TCFD members by the legal constitution of both international and domestic financial architectures, ANT provides an alternative line of critique. ANT is uniquely positioned to develop such critique as its forensic tracing of controversies is sensitive to the nuances of reformist contestations: Are contestations not taking place at all due to e.g. all members of a governance institution having fully internalised a shared set of norms? Or are contestations happening but shut down as in the case of the TCFD?

Second, by tacking the actors and accounts of their motives and intentions seriously (Latour 2005, 43–64) and by attending to the technical details of the research object, i.e. by following ANT's radical empiricism, existing critique of the TCFD and a disclosure-focused approach to climate change can be recalibrated. While previous critiques of the TCFD primarily focused on the assumed intention to steer financial markets through enhanced disclosure affecting changes in behaviour simply by the virtue of efficient markets (Ameli et al. 2020; Ameli, Kothari, and Grubb 2021; Christophers 2017), this paper's detailed ANT analysis both questions and reformulates this critique. It questions it by highlighting the awareness of multiple TCFD members around the unrealistic nature of the efficient market hypothesis. Those members did not have the intention to exclusively provide new information to financial markets but rather to incentivise organisational change within corporations and to elevate the profile of climate change within organisations. Furthermore, the function of the TCFD is not only limited to this indirect steering of corporate attention but reaches into the very areas that some authors explicitly specified as desirable governance approaches such as the introduction of climate considerations into capital requirements (Ameli et al. 2020; Ameli, Kothari, and Grubb 2021). Such advanced governance measures, however, are only justifiable and technically feasible with certain climate-related information being available at scale within financial markets – the kind of information that e.g. Mark

Carney personally forced into the TCFD recommendations. Only, for instance, if GHG figures are available across financial institutions can capital requirements be adjusted – whether to manage individual climate risk exposure or to incentivise low-carbon investment activities.

This questioning of previous critique is not meant to shut down critique or to justify a currently excessive reliance on disclosure measures as governance strategy within finance. It rather wants to facilitate a redirection of critique towards two issues currently neglected: pace and organisational practice. In terms of pace, the acknowledgement of the fact that disclosure requirements have functions beyond the provision of information to financial markets poses the question whether this indirect and sequenced approach to governing the intersection of finance and climate progresses at an appropriate pace. Are organisational practices changing at the speed needed to avoid a catastrophic climate breakdown with sufficient certainty? Are measures building on disclosures introduced where organisational change does not happen at the necessary speed? In terms of organisational practice, more attention should be paid to the drivers behind central banks' and financial supervisors' choice of disclosure as primary governance tool. If the assumption of previous critiques – i.e. a belief in the efficient market hypothesis – does not apply to the TCFD, it needs to be investigated whether it applies to FSB members or what else motivated their choice. Cognitive or cultural capture of central bankers and supervisors is possible (Kwak 2014; Özgöde 2021) but not the only explanation for their acts as they might equally be driven in their policy preferences by what instruments they have come to commonly use to govern finance, i.e. aspects of their organisational practice. This in turn might make them very well subject to the “infrastructural power of finance” (Braun 2020). To facilitate meaningful intervention, however, a precise diagnosis of the problem – a problem of neoliberal organisational practice or of neoliberal convictions – is crucial.

3.8. Conclusion

By employing ANT's sensitivities (Law and Singleton 2013) to the development of the TCFD recommendation, this paper conceptually contributes to the rich literature on private governance and empirically to a more nuanced understanding of the construction of climate risk and thus the governance of the relationship between finance and the planet's climate. Conceptually, this paper argues that individuals should be conceptualised as agents in their own right and as carriers of their own – potentially common good oriented – interest challenging a wide literature in private transnational governance explicitly or implicitly understanding organisations or organisation type as the relevant unit of analysis for identifying interests (Boström and Hallström 2010; Galland 2017; Klooster 2010). The paper also demonstrates the fluidity of interest coalitions within the task force further drawing into question to what extent interests can be reliably extrapolated from organisational parameters. These findings imply that research on how private governance produces policies needs to

take a more forensic approach to the identification of interests and how these interests shape governance outputs.

Empirically, this paper dissects the contested nature of how climate risk should be accounted for and thus makes a first step in interrogating the technical construction of climate risk from a critical social science perspective. With the construction of climate risk still ongoing, social scientists are currently in a unique position to witness the ontological politics (Mol 1999) of defining and calculating climate risk before agreements are reached and interests and choices become increasingly invisible in the black-boxes (Latour 1987; Latour, Woolgar, and Salk 1986) of naturalised frameworks, formulae, and models. Given the power of financial markets in shaping economic, political, and social realities combined with the urgency of addressing the unfolding climate crisis, this chance to critically accompany the construction of climate risk must not be missed.

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4. Avoiding catastrophes? The NGFS reference scenarios as translated climate futures

Abstract

Finance through its impact on economic activities indirectly shapes the fate of the planet's climate. Central banks as key governors of financial markets have recently started to engage with this relationship between finance and climate by creating climate scenarios as basis for prudential supervision. Bringing together Actor-Network Theory (ANT) and an emerging literature on imagining futures, this paper traces how central bankers and scientists designed these scenarios. It argues that to translate abstract climate futures into scenarios operational and legitimate within finance, they had to fulfil imperatives of four obligatory passage points (OPP): central banks' reputations, scientists' professional identity, mathematical models' technical specificities, and finance's operational practices. While each OPP introduced particular imperatives into the design process, OPPs are connected through relations of reliance while their imperatives partially reinforce and partially conflict with one another. These imperatives exclude certain types of futures from the design process, e.g. scenarios with high levels of financial stress or scenarios emphasizing justice considerations, shrinking the space of imagined climate futures for finance. By thus examining the ontological politics of how finance imagines its climate futures, this paper empirically contributes to our understanding of both the dynamics underpinning the envisioning of futures in the Anthropocene and the role of finance in responding to climate change. Theoretically, this study demonstrates how the imagination of futures can be conceptualised as translation thus advancing a nascent multidisciplinary literature on anticipation and imagining futures.

4.1. Introduction

In the era of financialization (Arrighi 2010) private financial actors have increasingly come to shape economic (e.g. Krippner 2005) and political (e.g. Streeck 2018) life since the 1980s. However, with the financial crisis of 2008 central banks have in many ways become the new ‘masters of the masters of the universe’ (Diessner and Lisi 2020) with monetary and prudential policy measures significantly affecting financial market dynamics, economic structures, and wealth distribution (Mackintosh 2017; Tooze 2021). Such policies affecting economic practice inevitably also affect the planet’s climate depending on whether capital is channelled towards economic activities with higher or lower greenhouse gas (GHG) intensity (see e.g. Matikainen, Campiglio, and Zenghelis 2017; Schoenmaker 2021). While long ignoring this link, central banks have recently started to actively engage with their relationship to climate change and organise around it: Founded in December 2017 by only eight central banks and financial supervisors, the Network for Greening the Financial System (NGFS) by now counts 114 members and pursues workstreams bringing environmental considerations into all areas of central banking and financial supervision.

Climate scenarios stand out as one of the key policy tools the NGFS has developed so far. These scenarios are set to become a common reference point in global and domestic financial markets to gauge and assess so-called climate risk, i.e. risk to financial assets, institutions, and systems posed by both the physical effects of climate change such as floods and storms and the impacts of a low-carbon economic transition triggered by climate change mitigation policies or low-carbon technological innovation (NGFS 2020; 2021b). One key area of application is the conduct of what is colloquially called climate stress tests, i.e. assessments of how financial institutions would fare under different climate scenarios (see also Langley and Morris 2020).

Beyond their global supervisory application from Mexico to the UK and Japan (see NGFS 2021b), these climate scenarios are emerging as critical operating system for how finance anticipates climate futures due to the combined authority of central banks’ regulatory and supervisory powers and the academic credentials of the research consortium tasked with the scenario development. With these imagined climate futures potentially delineating the space for future central banking policies as well as financial institutions’ climate strategies, i.e. with these scenarios as “political technology” (Doganova 2021) having political implications (see Garb, Pulver, and VanDeveer 2008), unpacking the forces and imperatives that shaped the scenario design process becomes critical for understanding how finance relates to the planet’s climate in times of a climate and ecological emergency.

Thus, this paper asks the question how these climate scenarios – the so-called NGFS reference scenarios – were developed. Actor-Network Theory (ANT) designed to follow the process of creating technologies and scientific facts (Latour 1987; 2005; Latour, Woolgar, and Salk 1986; Law and Hassard

1999) serves as conceptual framework to answer this question. This framework is finetuned to the topic at hand by drawing on an emerging literature in economic sociology, organization studies, and science and technology studies on the imagination of futures. Based on interview and observational data from conferences, workshops, and webinars, the paper argues that the reference scenario design process had to fulfil four related imperatives arising from its organisational environment: reputational, technical, professional, and operational imperatives. These imperatives have exclusionary effects throughout the scenario design process rendering certain futures unimagined. Thus, this paper makes significant empirical contributions to our understanding of the co-production of climate knowledge and of the limits of finance engaging with climate change. It thus responds to the call for social sciences to make visible ontological politics in the Anthropocene by “exposing, challenging and extending the ontological assumptions that inform how we make sense of and respond to a rapidly changing environment” (Lövbrand et al. 2015, 211). Conceptually, the paper demonstrates the value of ANT for tracing processes of imagining futures by unveiling diverse imperatives shaping the imagination process employing the concept of obligatory passage points.

The next section outlines the merits of an ANT approach and how it can be enriched with literature on the imagination of futures. The subsequent section provides a more detailed introduction to the NGFS reference scenarios before outlining the methods used for this study. The main section spells out how the four types of imperatives mentioned above shaped the design of the reference scenarios. The discussion section situates this study in the policy context through the lens of ontological politics and in the research context through the lens of loose ends. The conclusion reflects on the significance of imagining futures in times of a climate crisis.

4.2. Imagining climate futures as translation

While central bankers have been thinking about finance's futures under climate change since at least 2015 (see e.g. Carney 2015; Langley and Morris 2020), they faced a problem of translating these early concerns in three ways: first, how to translate abstract and non-financial ideas of physical and transition risk into representations legible and actionable within finance, i.e. how to express them in economic numbers; second, how to ensure comparability and homogeneity of such representations across financial institutions and jurisdictions to match the global and interconnected nature of financial markets, i.e. how to facilitate frictionless translation of representations between localities; third, how to translate events in the distant future into the present, i.e. how to translate future threats into present risk (see Power 2016, 275). The NGFS Reference Scenarios are an attempt by central bankers to address these translation problems simultaneously.

The sociology of translation (Callon 1986), better known as Actor-Network Theory (ANT) (Latour 2005; Law and Hassard 1999), provides a methodological sensibility (Law and Singleton 2013) and conceptual

toolkit to trace such attempts. Developed to investigate how scientific facts and machines are developed within science laboratories and engineering workshops, ANT is well suited to explore the design of model-based scenario simulations. ANT's understanding of agency in such processes highlights the role of non-human actors such as mathematical models in defining what can eventually become an accepted fact or a functioning technology (Latour 2005, 63–86; Muniesa 2015). The development of technologies such as the NGFS scenarios are not understood as a process of discovery of truths or correct designs but rather as a process in which human and non-human elements of an actor-network re-arrange or hold their positions until a route for translation has been found, i.e. a way of moving an issue or object – in this case climate futures – from one time and place to another, e.g. from climate science institutions to banks. Such a translation process needs to pass through certain unavoidable bottle necks to succeed, e.g. health and safety requirements for a machine or some other forms of approval of particular actors. Such bottle necks in a translation process are termed obligatory passage points (OPPs) (Callon 1986, 204–6; Latour 1987, chapter 4). Where an object or technology sits at the boundaries of different interest groups – as the NGFS scenarios sitting in between the central banking community, climate modellers, and financial institutions –, i.e. where it becomes a so-called boundary object, it typically faces multiple OPPs to pass through (Star and Griesemer 1989). During the process of translation, what is to be translated is typically transformed and moulded to satisfy the demands or necessities of OPPs. For instance, where a technology such as a map or an accounting table translates distant places and objects to a centralised location, these distant places and objects are only represented partially. A map, for instance, could be amended, cut, or projected differently to satisfy the needs of the centre (Latour 1987; 2005; Law and Mol 2001; Law and Singleton 2005). Thus, understanding the development of the NGFS scenarios as translation focuses attention on the dynamics of transformations the issue to be translated – climate futures – undergoes.

This ANT framework can be further finetuned by accounting for the specificities of what is being translated in the case of the NGFS scenarios: (climate) futures. Thinking about the future, attempting to tame uncertainties into manageable risk thereby creating new risks and additional uncertainties can be considered a defining feature of modernity (Beck 2010; 2016; Power 2007). Yet, the role of the future as productive force in and on the present has only recently attracted more scholarly attention in the social sciences (Beckert 2016, 3–6; Wenzel et al. 2020). In economic sociology research on 'imagined futures' has started to explore the origins of expectations in markets by foregrounding how narratives and calculative devices are employed to build confidence among actors in particular futures thus functioning as coordination mechanisms, as space for innovative blue-sky thinking, and as locus of political contestation (Beckert 2016; Beckert and Bronk 2018). This literature can enhance an ANT approach by qualifying the role of models and other calculative devices as actors which do in fact have productive effects but are potentially as much subjected to social consensus as social consensus is

subjected to model outputs (Reichmann 2018). Organization scholars, conceptualising future-making as organised and organisational practice, have highlighted the role of specific types and forms of knowledge in imagining futures and how such imaginations can serve as governance tools (Flyverbom and Garsten 2021; Thompson and Byrne 2022; Wenzel et al. 2020). This practice perspective emphasizes the organisationally specific and contingent nature of future-making processes posing questions on the particularities of organisational structures and available types of knowledge imprinting onto the futures thus produced. Bringing together science and technology studies and political science, Jasanoff and Kim (2015) and Wenger, Jasper, and Dunn Cavelty (2020) emphasize the duality inherent in future imaginaries constituted by and constituting both the technical and the political (see also Garb, Pulver, and VanDeveer 2008). This explicitly political formulation of the idiom of co-production (Jasanoff 2004), i.e. the mutual constitution of knowledge and social order, stresses the need to explore how political formations affect technological choices and how in turn technologies develop political effects.

Thus, the ANT framework guides this paper by making the identification of OPPs – central bankers, models, the science profession, and risk management practice – inclusive to non-human actors, i.e. models, and central to the research endeavour to identify the transformative effects these OPPs have on climate futures – i.e. the reputational, technical, professional, and operational imperatives. The literature on imagining futures calibrates this framework to the translation object at hand – (climate) futures – facilitating the identification of contingent risk management practice as OPP, allowing for a more nuanced engagement with the models underlying the reference scenarios, and guiding attention to neo-colonial dynamics surrounding them.

4.3. The NGFS Reference Scenarios

By developing their reference scenarios and conducting scenario analyses, the NGFS is employing a method used in contexts as diverse as military strategizing or business planning (see e.g. Garb, Pulver, and VanDeveer 2008, 4). Scenario analysis' basic principle is to map out a range of possible futures to inform pro-active strategies and build re-active capacity in the face of uncertainty. The current version of the NGFS reference scenarios – which are set to be updated on a yearly basis – published in summer 2021 comprises six bespoke scenarios. Using a common approach in scenario analysis (Dunn Cavelty 2020, 93–96), the NGFS identified two critical risk drivers – transition and physical risk introduced above – and created a matrix which was subsequently populated with scenarios mapping the space of futures of interest (see Figure 5). Grouped into pairs of two each for an orderly transition, a disorderly transition, and a lack of a transition toward a low-carbon future, the scenarios – in a nutshell – capture distinct imaginaries of climate futures (see NGFS 2021a).

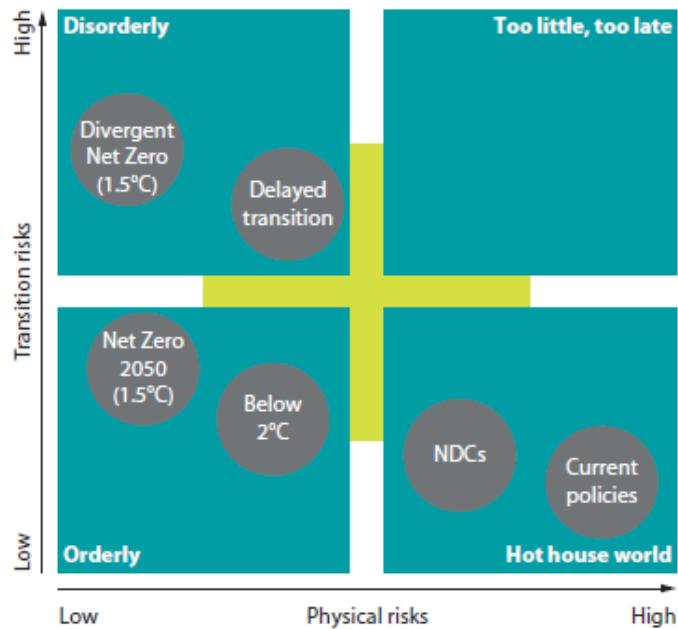


Figure 5: climate risk quadrants (source: NGFS 2021a, 7)

- “Net zero 2050” imagines immediate and stringent climate policies leading to a world in which by 2050 the net CO₂ emissions are zero and the global average temperature is likely to have increased by 1,5°C by the year 2100.
- “Below 2°C” equally envisions stringent and gradually tightening climate policy measure which, however, remain below the levels of the “Net zero 2050” scenario and hence result in global warming below 2°C by 2100 with a 67% probability.
- “Divergent Net Zero” deviates from the cost-optimal “Net Zero 2050” scenario and assumes policy measures diverging across sectors hence increasing the costs of meeting the net zero emission target by 2050.
- “Delayed transition” imagines climate policies to strengthen only from 2030 onwards demanding forceful policy measures even for meeting the below 2°C goal.
- “Nationally Determined Contributions (NDCs)” assumes all climate pledges taken by national governments so far will be fulfilled leading to 2,5°C of global warming.
- “Current Policies” envisions a world in which current climate policies are neither weakened nor tightened leading to an imagined 3°C warming outcome.

These scenarios are being developed in collaboration between the NGFS and a research consortium specifically created for this task. Within the group of NGFS members the Bank of England (BoE) and the Banque de France (BdeF) hold particularly central positions as they respectively lead the NGFS workstream within which the scenario project is situated (BoE) and provide the Secretariat to the NGFS

coordinating and providing support to all NGFS projects (BdeF). Only a handful of other NGFS member organisations have actively and continuously contributed to the scenario work so far. The research consortium largely consists of academics and researchers affiliated with well-established institutions in the Global North which have a track record of contributing to the global efforts of bringing together, comparing, and advancing climate mitigation scenarios feeding into IPCC reports (see Table 5). Thus, the model teams recruited into the research consortium are a sub-group of the modelling community producing IPCC scenarios. Hence, members of the research consortium are mostly individuals routinized in generating climate scenarios.

Thematic focus	Organisation
Physical risk	Potsdam Institute for Climate Impact Research (PIK), Germany
Transition risk	
Project coordination	
Transition risk	International Institute for Applied Systems Analysis (IIASA), Austria
Transition risk	University of Maryland, USA
Physical risk	Climate Analytics, Germany
Physical risk	ETH Zurich, Switzerland
Macro-economic modelling	National Institute for Economic and Social Research (NIESR), UK

Table 5: member organisations of the research consortium

The approach to employ the type of models and organisations contributing to the IPCC climate scenario development outside of this IPCC process at this scale is unique – largely because of how resource-intensive it is. In fact, the NGFS relies on philanthropic money from two US based charities – the Climateworks Foundation and Bloomberg Philanthropies – to fund this multi-million-dollar endeavour. The uniqueness of this project further secures the reference scenarios' status as global standard and reference point – primarily for financial institutions, central banks, and supervisors but potentially by extension for other capital market participants such as publicly listed companies.

As the above outline of the organisations involved in the scenario project shows, the development of the climate scenarios is dispersed across multiple sites. This spread grows even further when taking the models and databases employed into account. In short, the reference scenarios are a complex assembly of an array of outputs from different model types which in turn are the endpoints of a long model cascade. This complexity can be illustrated – not fully captured, however! – by a schematic and superficial outline of the computation of key indicators for physical and transition risk respectively.

The carbon price as instance of a transition risk indicator is computed using Integrated Assessment Models (IAMs). As the name suggests, these models in turn integrate multiple models – typically a simplified climate model, an energy system model, a land system model, and an economic model.

Similar to Global Circulation Models (GCMs), which simulate the planet's climate, the production and hence knowledge about IAMs is thus again dispersed across modellers (see Lahsen 2005). To obtain a physical risk indicator such as an estimate of economic damage from flood events, a database compiled by the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) is employed. More than 100 different models provide inputs into this database (Bertram et al. 2021, 53). Thus, a single estimate of economic damage from e.g. river flooding is the product of a chain comprising, for instance, a GCM already too complex to be developed and maintained by a single modelling team (Lahsen 2005), a model to simulate flood pathways, another model to simulate flood depths, and eventually a so-called damage function to translate physical indicators into economic damages. In the context of the NGFS reference scenarios, these model cascades have been extended by an additional macro-economic model supplied with outputs from IAMs and physical risk models.

This dispersed yet interconnected and thus highly complex nature of the organisational and modelling infrastructure underlying the climate scenarios has at least three important implications: First, it highlights the scale of the endeavour to create climate scenarios such as the NGFS Reference Scenarios and thus underscores their unique status and the barriers to create alternative challenger scenarios. Second, it calibrates the analytical perspective of this paper in the sense that models – or calculative devices as economic sociology has it – even more clearly become actants, i.e. objects with agency (Latour 1987; 2005), as even the most expert human actors have to blindly rely on at least some elements in the model cascade without having the knowledge or technical skills to assess or adapt them. Third, the wide dispersion and indefinitely complex nature of model cascades makes it impossible to trace the entire scenario design translation process. However, knowledge production in general and climate knowledge production in particular is embedded in specific localities and therefore contingent and specific itself – even where it is multi-sited and global in its gaze as in the case of GCMs (Mahony and Hulme 2018). Hence, it is paramount to clearly delineate the boundaries of this study in terms of how far these local specificities can be investigated. This issue will be addressed in the following methods section and the discussion section.

4.4. Methods

The data underlying this study was collected in two phases employing three different methods. In a first phase running from January 2019 to December 2021 observation was carried out at conferences, workshops, webinars, and Q&A sessions dedicated to aspects or the whole of what is now known as the NGFS reference scenarios (see appendix A). Since these events ranged from highly technical workshops on databases or modelling choices in the scenario design process to high-level discussions of e.g. the role of climate scenarios in macro-prudential supervision, the data thus collected instructs all layers and dimensions of the analysis. Specific to the observational data is that it captured moments

of interactions between actors inside the scenario project and those outside of it, e.g. other academics, NGO representatives etc., who often confronted insiders with divergent views allowing a better view on how and to what extent the scenarios were shaped by demands residing outside of the formal structures of the design process. All events observed were open to the public with the exception of three NGFS-INSPIRE workshops in November and December 2020 which were not publicly advertised and could only be accessed by invited participants.

In addition to observation, relevant publicly available documents were collected and reviewed during this first phase of data collection. These documents comprise all official NGFS publications on their climate scenarios – most importantly the technical documentation (Bertram et al. 2021), the launch material for the second vintage of the scenarios (NGFS 2021a), and the websites set up to make the scenarios accessible to the wider public – and academic publications on aspects of the scenarios such as particular technologies central to the energy system model (e.g. Fuss et al. 2018), model or scenario documentation (e.g. Calvin et al. 2019; Fricko et al. 2017; Riahi et al. 2017), or general overview papers on specific modelling approaches relevant to the reference scenarios (e.g. Piontek et al. 2021). The data collected through these documents increased the granularity of understanding of relevant data and models.

These two modes of data collection prepared the second phase in which 25 semi-structured interviews were conducted between June and November 2021 with NGFS members and members of the research consortium. Interview questions were tailored to each individual interviewee depending on their role within the scenario design process but were structured by the themes summarized in appendix B. Apart from instructing the interview questions in detail, the first phase of data collection guided the focus of the interview to the second set of scenarios published in 2021 rather than the first vintage which consists of more generic ‘off-the-shelf’ scenarios. Hence, the more bespoke second set of scenarios provides more insights into the ways of how central bankers imagine climate futures. Given the relatively small number of individuals involved in the scenario design process, the 25 interviews capture the vast majority of relevant actors with the exception of two individuals on the side of the research consortium and one individual on the NGFS side.

Despite this relatively comprehensive coverage via interviews, the complexity of scenario construction process outlined in the previous section introduces limitations to this study. Only individuals directly involved in the scenario design process were interviewed leaving several layers of modelling choices and scenario design decisions outside of the scope of this study. This limitation is partially compensated for throughout this paper by drawing on an extensive literature on climate modelling (Fiedler et al. 2021; Heymann, Gramelsberger, and Mahony 2017; Lahsen 2005; Lenton et al. 2019), integrated assessment modelling (Battiston et al. 2021; Beck and Krueger 2016; Cointe, Cassen, and

Nadaï 2019; Ellenbeck and Lilliestam 2019; Haikola, Hansson, and Fridahl 2019; Low and Schäfer 2020; Pindyck 2013; Stern 2013) and the IPCC and its climate scenarios (Beck and Mahony 2017; 2018; Buhaug and Vestby 2019; Carlsen, Klein, and Wikman-Svahn 2017). However, it is crucial to re-emphasize that this study is exclusively concerned with the development process of the NGFS scenarios and therefore likely misses most design choices not discussed throughout this specific design process. Since this study focuses on the actors directly involved in the scenario design process it also neglects the role of the philanthropic donors which did not take part in the development phase of the scenarios.

The transcription of the interview data served also as phase of data immersion which led to the deductive development of 17 codes (see appendix C). Throughout the subsequent empathetic coding process (see Willig 2014) these codes were specified where possible and progressively combined where boundaries between codes became blurry or common umbrella themes could be developed. Additional codes were created where common themes or important aspects in the data did not squarely fit into the existing coding frame. Other codes were abandoned where the empirical material proved insufficiently deep or robust. This process resulted in the final set of codes summarized in table 2. Subsequently, the coded data was re-read to both identify relationships between the codes (Bazeley 2009) and to position them vis-à-vis the conceptual framework developed earlier in this paper. In short, this process resulted in the identification of OPPs to which codes could be assigned exclusively or which were connected by a code (see Table 6). The codes which could not be fitted into this framework all pertained to effects or dynamics downstream of the scenario design process and are therefore beyond the scope of this paper. Given their relevance, however, this data is worked into the discussion section.

Code (previous codes)	Definition	OPP
Avoiding politics (new code; <i>indecisiveness</i>)	Accounts of how choices were made or decisions were avoided with the goal to circumvent 'political' disputes	Central banks
Goals & purposes (new code; <i>standardization</i>)	Accounts of the various goals and purposes ascribed to the Reference Scenarios	Central banks
Use & implementation (new code)	Statements on the actual or prospective use of the scenarios and the implementation of scenario exercises	/
Legitimacy & expertise (<i>expertise; neutrality; openness & transparency; reputation</i>)	Accounts of how expertise functioned as source of legitimacy or how the lack of expertise was compensated for to not become a legitimacy liability	Central banks – science profession – models
Models (<i>financial sector; models; path dependency</i>)	Accounts of models resisting, shaping scenario choices etc.	Models
Unrealistic nature of models (<i>numbers</i>)	Accounts of how model assumptions or structures are perceived as unrealistic	Models
Usability (<i>Anschluss-fähigkeit; feasibility</i>)	Statements on how usability considerations shaped scenario design choices	Risk management practice

Scientific caution (caution)	Statements on scientific caution guiding design choices/decisions	Science profession
Stress (old code)	Statements on the level of stress captured in the scenarios	/
Time constraints (old code)	Accounts of time constraints affecting the scenario design process	Central banks – models

Table 6: second coding framework

4.5. Developing the NGFS reference scenarios

4.5.1. Central banks and reputational imperatives

As the NGFS is a network of central banks, the reference scenarios had to align with or at least not contradict the general goals and interests of the central banks involved. Two aspects of these goals and interests linked with reputational and legitimacy concerns shaped the scenario development process in particularly substantive ways similar to how reputational considerations affect the very identification of problems and risks in regulation (Baldwin and Black 2016). The first one relates to the inherent ambition of key central bankers within the NGFS to be or to appear as active and leading in addressing climate risks as new threat to financial stability and to effective monetary policymaking. These ambitions are particularly pronounced amongst European central bankers (Carney 2019; Coeuré 2018; Knot 2015; Lagarde 2021). The ambitious mindset partially grows out of the concern to miss the closing window to keep climate risk manageable and partially out of a competitive pressure among central banks to not fall behind central banking peers in terms of climate risk assessment.

“We central bankers, especially in Europe, are under great pressure from the heads of central banks of the euro system [...]. So it's [climate risk] becoming one of the highest priority for the financial and central banking community. And we need to move forward. [...] And, and this kind of thing is quite, it's becoming quite competitive right now so every jurisdiction wants to have its own stress test, or scenario analysis, or whatever on climate, to show that they are very committed to the topic. [...] So if a central bank is not active on this topic, it's perceived as not committed to climate change. And this, yeah, it's kind of judged, also in the press.

So it's a matter of the visibility and reputation.” – NGFS3, 20.07.2021⁷

This sense of urgency and ambition creates a significant time pressure for central bankers within the NGFS and hence for the reference scenario project. The scenarios as basis for climate risk assessments

⁷ All quotes are presented in English. To ensure anonymity of the interviewees, it is not indicated where a quote was originally spoken in English or where it was translated from German. Six of the 25 interviews were conducted in German.

are critical for obtaining or maintaining an image of prioritising the issue of climate risk in a fast-paced environment driven both by peer competition and by the closing time window within which a low-carbon transition without major disruptions to financial systems seems still feasible.

In the context of the reference scenario project, this sense of urgency and ambition meets a deeper layer of what a desirable reputation and image of a central banker is: the image of a central banker as an impartial expert and neutral bureaucrat. Central bankers – while of course not fully homogeneous (see e.g. Adolph 2013) – constitute an expertise-based community which derives its authority from its identity as group of technocrats holding certain subject-matter knowledge while being independent from government and other political influence (see e.g. Hall 2008, chapter 6; Mackintosh 2017). While central banks' neutrality has been questioned in multiple contexts (Adolph 2013; Colesanti Senni and Monnin 2020; Matikainen, Campiglio, and Zenghelis 2017; van't Klooster and Fontan 2019), impartial expertise remains the core justification for their authority. To maintain their expert status in the face of a clear lack of climate-related expertise, the NGFS central bankers in a first step recruited those organisations into the research consortium which had a strong expert reputation in the climate science and climate scenario building space. In fact, a 'good reputation' (NGFS2, 16.07.2021) was a key selection criterion for research consortium members alongside availability at the time scales envisioned for the scenario development project and a global coverage of employed models reflecting the global membership of the NGFS. Central bankers have built such alliances with academic specialists to legitimise novel approaches before in different contexts (see Thiemann, Melches, and Ibrocevic 2020).

In addition to borrowing the expert legitimacy of the research consortium members, the NGFS team also maintained its neutral expert status by both re-actively and pre-emptively avoiding controversies. This imprinted on the way the reference scenarios were presented – the label 'representative scenario' for some scenarios were dropped after NGO criticism that no 1.5°C scenario was awarded such a label – but also on substantial scenario design choices. For instance, scenarios in which governments do not meet their climate policy targets which so far has been the reality for most national climate targets, was consciously avoided.

"If we're going to do an exercise, and our government has said, we'll reach zero [CO₂ emissions] by 2050 and we have a scenario that says, we're reaching net zero by 2070. That's just gonna turn around and say, like, what are you doing? You know, you're undermining our policy!" – NGFS6, 24.08.2021

In addition to such pre-emptive avoidance of controversies with governments potentially challenging the authority of the NGFS and its scenarios, central bankers also reacted to emerging controversies by

adapting scenario designs. Most notably, the availability of carbon capture and storage (CCS) technologies was reduced for the second version of the reference scenarios (see NGFS 2021a) due to 'public discourse' (RC14, 22.09.2021) turning against the reliance on such unproven technologies and stakeholders publicly criticising the first version of the reference scenarios on that ground (see e.g. Reclaim Finance 2021). The avoidance of controversies by central bankers, i.e. the depoliticization of their work, is again not restricted to the issue of climate change (see Levingston 2020).

Thus, the two aspects of central bankers' image and reputation – namely their ambitions in the climate risk space as well as their reliance on expertise-based authority – created the reputational imperatives to appear as active and leading by moving fast in developing climate scenarios and to uphold the image of expertise-based decision making. These imperatives created, first, an intense time pressure, second, the need to recruit members of the research consortium partially based on their reputation, and third, a disposition to avoid controversies and depoliticise their work. All these effects of the reputational imperatives amplified what this paper calls technical imperatives materialising in the form of path dependencies set by the models which had to be used for their reputation, which became a means to avoid controversies, and which could not be substantially adapted due to the tight project timeline.

4.5.2. Models and technical imperatives

Thus being rendered an obligatory passage point, the characteristics of models started imprinting themselves onto the climate futures imagined by the NGFS in multiple ways.

4.5.2.1. *Models resisting alternative imaginations*

Models insisted on their version of possible futures and resisted both central bankers' and researchers' imaginations when the controversy around CCS availability needed to be addressed. None of the three IAMs participating in the scenario development process allowed for plausible futures without any substantial CCS deployment. They resisted either by increasing policy interventions to a level deemed 'crazy' or they simply would not solve, i.e. not compute any outputs.

"But if you want to be able to test for net zero by 2050 like your numbers look insane if you don't have some CDR [carbon dioxide removal] in there, so I guess it became a bit of a balancing act like we are criticized for having too much CDR in there in the first step, which I think is fair, like fair criticism. And so we were keen to have less. But we also knew we couldn't, for some scenarios, we couldn't just take it out." – NGFS6, 24.08.2021

"And we essentially reduced them [CDR levels] as much as we possibly could in the model without models breaking" – NGFS9, 09.09.2021

In fact, the models were the reason why CDR was part of the NGFS' imagined climate futures in the first place.

"So when we talk about these negative emission technologies they are... well, one they were already in the models. So, you know, it was a, it was not something that we added later on. It's, this is there, so we kind of have to assume how do you want to calibrate it? That's the, that's the question. So it's not so much a question do you want it or not." – NGFS2, 16.07.2021

To what degree CDR availability could be reduced also depended chiefly on the models with researchers scrambling to find a balance between the demand for low CDR levels and 'insane numbers' the models produced in turn. With each IAM having its own unique structure and configurations, what eventually became a 'low' level of CDR availability differed between IAMs (see Figure 6) and was not decided by e.g. academic takes on plausible levels of CDR (as in Fuss et al. 2018) but by model characteristics. Most decisive in determining possible CDR reductions are the level of discount rate chosen and assumptions about alternative technologies, e.g. renewable energy technologies, and their respective share in the overall energy mix. The former factor, discount rates, is a fiercely contested issue with no consensus about its 'correct' value given the underlying fundamentally ethical choice of whether or not to devalue future generations' lives (Beck and Krueger 2016; Ellenbeck and Lilliestam 2019, 73; Pindyck 2013; Stern 2016).⁸ Hence, tradition and model default settings determined this crucial piece of the IAMs.

"What's the most justifiable interest rate? No one has a good answer. So we just keep the tradition." – RC2, 05.07.2021

Discount rates were not discussed and all IAM teams confirmed that the respective model's 'default setting' was used for the NGFS scenarios – a default setting which varies from 3% to 5% depending on the IAM. Other technology assumptions, on the other hand, were sometimes actively adapted to accommodate a lower level of CDR availability. Thus, more conservative assumptions around CDR were compensated with more optimistic assumptions for other technologies.

"So yeah, just a lot of share weight adjustments. And I think maybe even adjusting the costs of the different technologies so that you know like solar and wind come in more relative to CCS." – RC10, 11.08.2021

⁸ For a wider discussion of the technology of discount rates outside of the IAM community see Doganova (2021).

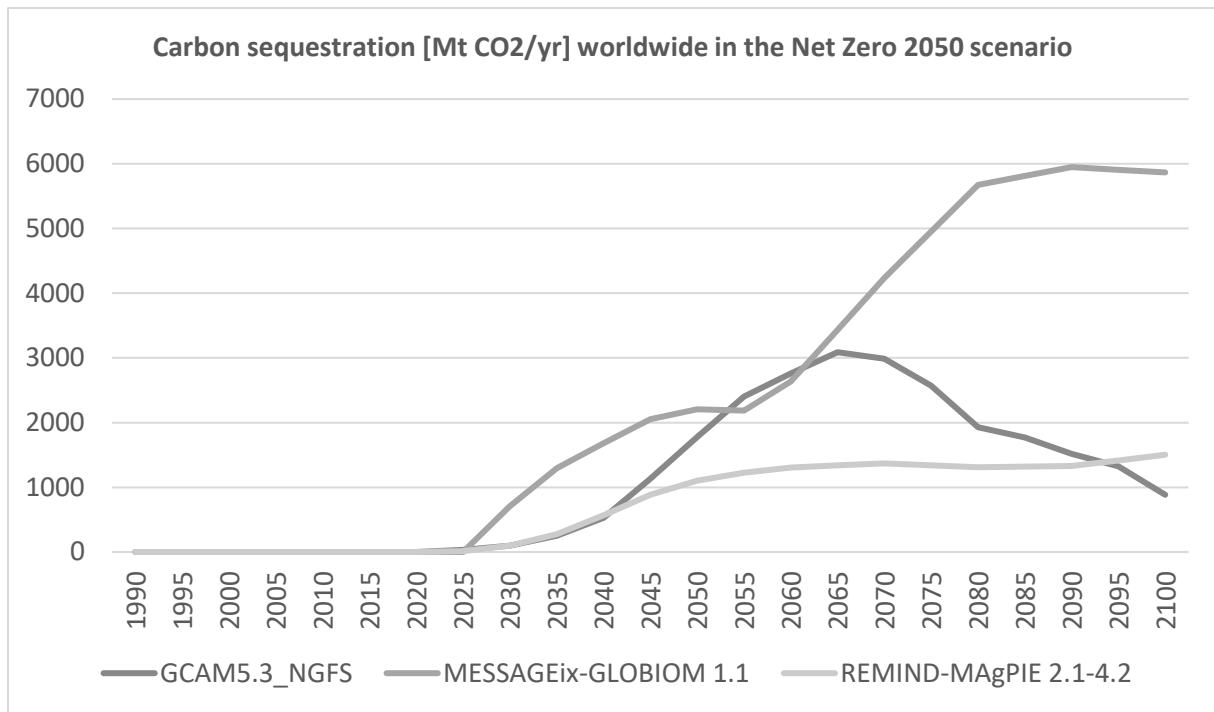


Figure 6: carbon sequestration pathways (source: NGFS Scenario Explorer hosted by IIASA, release 2.2)

The model's climate futures did not only resist imagination of futures with less CDR availability than what discount rates and technology configurations allowed but also seemed to crowd out alternative pathways toward such futures.

"You need like a carbon price of five or \$10,000 a tonne for this to work, which is essentially just saying you need to ban the use of fossil fuels completely. Which yeah, I mean, it's, it's, it's definitely, [pause] yeah, it's definitely plausible, that we'll get to that point, but not within, under the constraints of the model that we're working with." – NGFS9, 09.09.2021

Pathways toward 1.5°C which are not easily computable within the mechanics of the models employed, from moderate reforms like targeted consumption reductions of non-essential goods and services to more radical reforms such as the shift to a steady-state economy with greater focus on e.g. wellbeing rather than GDP, are kept out of imagined futures. Futures relying on reduced energy consumption and hence GDP levels in developed economies as main tool to achieve the 1.5°C goal rather than on the large-scale and rapid deployment of unproven technologies (Diesendorf 2022; Keyßer and Lenzen 2021) are thus excluded from the discourse around finance's climate futures.

In some instances, scenarios for central bankers also seem to become less of a heuristic device and more of a truth machine representing reality as it is rather than as it might be (see Lahsen 2005).

“And, and then you start to sort of think, actually, there are good reasons why these models are suggesting that some CDR might be helpful as to invest in, in parallel to investing in other technologies, because the, the almost like, the only other option suggested by the models is shutting down large parts of the economy.” – NGFS9, 09.09.2021

“Actually, in those most ambitious scenarios, it's understandable that CDR is a bit higher, because, for instance, there is higher investment in green technologies. And so that's, that's okay, I think to have CDR a bit, a bit higher in the scenarios.”

– NGFS10, 17.09.2021

However, the IAMs have not fully colonized all central bankers' imagination with reliance on CDR still being perceived as problem, especially when the scenarios thus produced are meant to instruct stress testing exercises.

“If you want to reach ambitious climate targets, you have to assume CDR will work. But evidence in terms of like the investment going into it, like all of it suggests, it's not, it's not, there's a big question mark, right? And so this becomes a bit political as well. And so if you want to use it for stress testing purposes, and you really want to test your financial systems, then you don't want your firms to assume that lead to CDR because effectively it's assuming the problem away, right?” – NGFS6, 24.08.2021

Yet, the reputational imperatives creating time pressure and reliance on models with a 'good reputation' kept the NGFS from using alternative models to imagine climate futures which rely on lower levels of CDR as in the case of a scenario produced by the International Energy Agency (IEA) (RC3, 07.07.2021) or which exclude such unproven technologies altogether as in the case of a model employed by an NGFS member organisation for its own climate scenario analysis (NGFS8, 08.09.2021).

4.5.2.2. *Models rendering technical*

Deploying CDR and more precisely bioenergy combined with carbon capture and storage (BECCS) technology in imagined climate futures has sparked controversies in the context of the IPCC scenarios. The political implications of dedicating large areas of land to this negative emission technology potentially infringing on indigenous peoples' land rights and increasing food prices are significant (Beck and Mahony 2018; Calvin et al. 2019, 687; Haikola, Hansson, and Fridahl 2019; Low and Schäfer 2020; Rayner 2016; Rogelj et al. 2019, 362). In that sense, leaving the decision how far to reduce BECCS availability in imagined climate futures to models is a move to render this political question technical (see Li 2007) and thus maintain the expertise-based authority of the scenarios.

An even more pronounced instance of models shaping imagined climate futures due to the NGFS' need to render political questions technical is the case of carbon pricing. IAMs approximate the stringency of climate policies with one single indicator: a shadow carbon price. Orthodox economic theory concepts of perfect markets and cost effectiveness provide the intellectual foundations for cloaking within IAMs where decisions about climate policies are left to assumed and modelled monetary cost structures.

"If the model would have like hundreds or 500 specific policy measures on the table, and you would tell 'Hey, now take your measures such that you don't exceed this limit of CO₂ emissions', you would still for the model need to order those or rank those in terms of their, their, their cost effectiveness. Otherwise, it's just gonna take random policy measures here and there through the, through the century until it sort of matches that, meets that boundary, right? Logically, from that perspective, the price is the way to implement, implement that." – RC5,

20.07.2021

The carbon price allows both modellers and central bankers to imagine climate futures without openly crossing the line into political territory of deciding what kind of climate policies could or should be enacted, when, and where. Thus, the usefulness of this specific imagination of future climate policies trumps its crude character similar to the adoption of inaccurate models in financial institutions due to their organisational usefulness (MacKenzie and Spears 2014; Millo and MacKenzie 2009).

"How do we deal with climate policy? We have a shadow carbon price, it's a total cop out, like, it's a summary of all the policies, you need to achieve a certain thing. But in itself, it's not actually anything, right? Like, what is it, it's combination of regulation and carbon price and taxes and all the rest of it. But if we say, Oh, this is, you know, like it would be, it could be interpreted as the central banks are saying, and this is how you need to do climate policy. That's not for us to say. And so this is a way for us to say, but we need something that allows us to model this. And you could say, you know, it's hard to model the full economic impact if you don't have the different policies, but a totally fair criticism of the scenarios, that allows us to do the modelling in a standardized way, and allows us to do analysis in a way that we can publish and we can communicate on. So it becomes a very effective tool for us to operate in the space." – NGFS6, 24.08.2021

4.5.2.3. *Models with a Northern gaze*

Models do not only help central bankers to effectively enter the space of politics while simulating to remain in the realm of technicalities. They also allow them to develop a ‘global gaze’ (Mahony and Hulme 2018) by simulating a representation of the whole world while effectively remaining firmly anchored in the Global North. Several models’ origins within the Global North are reflected in different and sometimes problematic ways in the model workings. For instance, growth projections for Africa used for both the IPCC and the NGFS reference scenarios are wildly optimistic and do not account for the typical growth paths of African countries (Buhaug and Vestby 2019). This might lead to an underestimation of transition risks. Physical risks are also likely to be captured particularly poorly in developing and least developed countries since the underlying models are calibrated with datasets from the Global North where historically more data has been collected due to e.g. the economic capacity of the Global North to fund such data collection efforts thus translating existing economic inequalities into unequal capacities to assess climate risks. Furthermore, the type of data being used in some models is sometimes inadequate for the context of developing and least developed countries. For instance, some physical hazard models rely on night light data to approximate the location of economic assets. This approximation works relatively well for industrialised countries. It structurally omits agricultural assets, however, which are not lit up during night-time unlike e.g. industrial sites or cities. As one of the modellers put it:

“So if you’re interested in damage on agriculture, because your country is almost only agriculture, then you should understand that these estimates will not really be representative” – RC6, 21.07.2021

Going beyond the varying accuracy of models depending on economic and geographical context, the NGFS reference scenarios take positions regarding the distribution of greenhouse gas emission reductions discussed above. Such positions might be at odds with how climate futures in the Global South might be imagined, e.g. in terms of a just transition rather than a cost-optimal transition. The NGFS reference scenarios provide no basis for imagining such futures and might even crowd out such alternative imaginaries given the limited resources available in developing and least developed countries to design such scenarios from scratch.

4.5.2.4. *Models as gatekeepers*

Models by definition are simplifications of reality and therefore necessarily omit certain aspects of it. While thus not problematic as such, omissions still deserve attention, especially where they have been decided on in contexts different from the application context in terms of priorities, goals, and norms – as is the case with models used for the NGFS scenarios. For instance, the financial sector and its effects on the feasibility or smoothness of any low-carbon transition is completely left out of the NGFS

scenarios despite its effects on stalling or accelerating said transition and despite the NGFS scenarios' purpose to aid a better understanding of the links between finance and climate change (Battiston et al. 2021).

"I think it was largely driven by what was available. So integrated assessment models don't typically come with a financial sector. So it's not that...we didn't really have that, that choice" – NGFS 2, 16.07.2021

In the realm of physical risks models function as gatekeeper, too:

"So it's not a choice [about the selection of physical hazards] that we made, that we made ex ante to be very transparent, it was because the [research] consortium is keeping working and adapting their scenarios. So they were available to include these hazards. And we said, okay, amazing, but we didn't pick them up ex ante.

We just took what they were working on." – NGFS3, 20.07.2021

The research consortium in turn was driven by data and model availability and compatibility which – in their eyes – left them with no other choice than the hazards they eventually included in the scenarios, especially in the context of tight deadlines dictated by the reputational imperatives discussed above.

"And for our CLIMADA exercise where we only have tropical cyclones and flood risk. The reasoning was pretty easy, tropical cyclones is a well-established model. [...]. And river flood was just a new project. And so this new data set which was delivered, so it was, yeah, I wouldn't say there were choices. [...] There was not really reasoning about it. [...] Yeah, I wouldn't say there were choices." – RC4,

19.07.2021

"And so we just took what was ready to be done, because it was not a research project. So that was what we could deliver. Without, well, within the boundaries of that project." – RC6, 21.06.2021

This gate keeping function is not limited to individual physical hazards such as e.g. bushfires or storm surges which were excluded from the scenarios but it extends to fundamental properties of the physical world, namely earth system tipping points which are not represented in the NGFS reference scenarios despite their significant impact on carbon budgets and hence mitigation pathways (Lenton et al. 2019). These exclusions were not made on the basis of the significance of respective effects on model outcomes with e.g. only less significant factors being omitted but to a large degree based on model availability. However, the exclusion of a wide range of physical hazards and tipping points

cannot exclusively be explained by an overpowering agency of models. The professional identity of scientists as well as organizational practices within finance covered in the following sub-sections act in tandem with the models.

4.5.3. Scientist identity and professional imperatives

For the reference scenarios to become authoritative and thus effective in translating climate futures, they needed to pass through the OPP of science represented by the scientists of the research consortium. Scientists in general but scientists working on politically contested topics such as climate change in particular in turn rely on clear boundaries between their domain of science and the domain of politics, speculation, or other non-scientific modes of knowing and reasoning (see e.g. Beck and Mahony 2018). These boundaries require maintenance, so-called boundary work (Gieryn 1983; Lynch 2004). What Gieryn (1983) calls ideology of science, i.e. a certain depiction of science co-constituted by situation-specific interests and strains from conflicting roles, this paper conceptualises as *scientist identity*. This shift in terminology seems appropriate as – in the case of the reference scenarios – the discursive performance of science does not take the form of an actively articulated opposition to competing ideologies such as religion or national security but rather that of deeply engrained professional values and norms which, however, fulfil functions similar to those of Gieryn's ideology of science.

The scientist identity introduces professional imperatives into the scenario development process, most notably the imperatives of scientific caution and of scientific neutrality. The effects of the latter become visible during the examination of the role of carbon pricing within IAMs. Globally uniform carbon pricing, while implausible as actual representation of climate policies, proved useful to perform political neutrality. A similar example is the 'downscaling' of global IAM outputs to the country-level conducted for the second version of the NGFS reference scenarios. In a nutshell, emission reduction pathways for this phase of the scenario development process were computed for every single country rather than globally, posing the question of how to distribute the burden to cut emissions. The modellers' reliance on historical trends and the status quo in imagining future decarbonisation paths rather than e.g. historical responsibilities (e.g. Friman and Strandberg 2014) or the meeting of basic needs (e.g. Rao, Min, and Mastrucci 2019) presents another example of rendering political questions technical; in this instance in order to insulate scientists rather than central bankers from the critique of encroaching upon the domain of politics by performing scientific neutrality.

The imperative of scientific caution fulfils the function of boundary work as well, insulating scientific communities from politics and criticism. It becomes literally visible in the graphics visualising model outputs which include wide uncertainty margins and emphasise how different models produce different outputs in order to ensure the scientist from any culpability of being misunderstood as

making precise claims or forecasts (see e.g. Figure 7). The imperative of scientific caution shapes the NGFS reference scenarios on a deeper level as well, namely by excluding certain aspects of physical reality from imaginaries of the future already introduced in the sub-section on technical imperatives. In fact, many additional models and databases could have been brought in by the research consortium to imagine natural hazards. The examples of sea level rise and alternative damage functions – mathematical formulas translating physical damages into economic numbers – illustrate the workings of scientific caution.

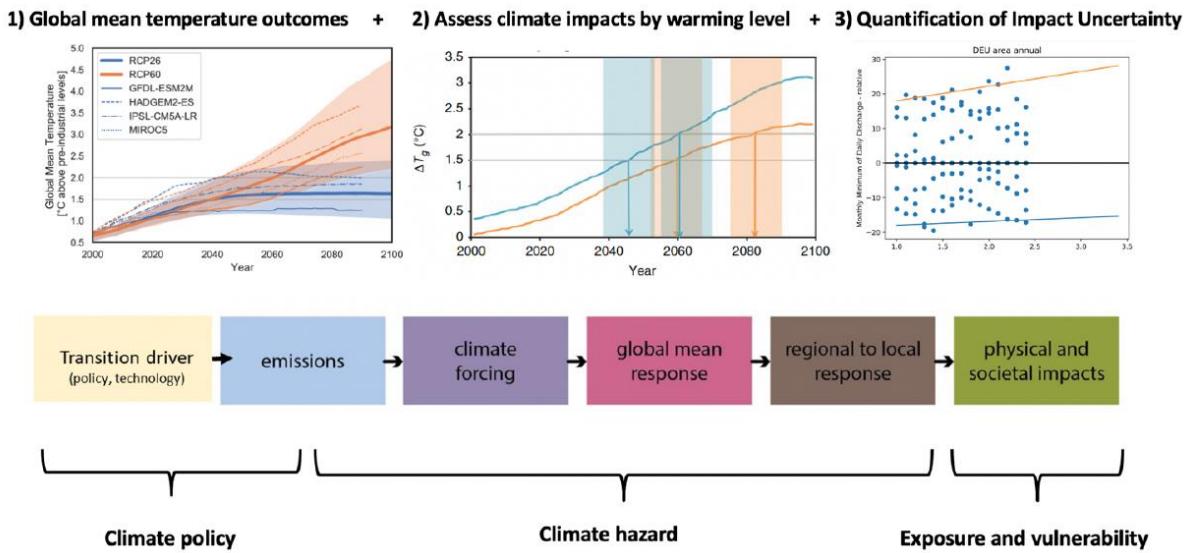


Fig. 2 Illustration of the various sources of uncertainty in the climate impact chain (see coloured squares at the bottom), and the 3 key methodological steps applied to account for those in the projections shown by the Climate Impact Explorer.

Figure 7: sources of uncertainty (source: Climate Analytics 2021, 6)

In the case of selecting damage functions, the scenario development team faced a dilemma: They had to select one single damage function despite seeing none of them as producing accurate results. Put simply, two types of damage functions exist: those which only capture effects on GDP levels and those additionally capturing effects on GDP growth rates (see e.g. Piontek et al. 2021). Central bankers advocated to use a damage function of the latter type which produces higher damage values and which was considered to be closer to the actual level of future damages than a damage function of the former type which produced – everyone agreed – damage values that were too low. Eventually, however, the NGFS – relying on the scientists' approval and authority – accepted the scientists' decision to use the damage function certainly producing values too low. The scientists' reason was a lack of theoretical robustness of the damage function producing higher and more plausible results.

“So a bit of this feeling that the damages should be higher than they are, which is not wrong. Still, this other estimation is not robust and that’s why we were reluctant to use it.” – RC15, 29.09.2021

In the case of excluding effects from sea level rise into the scenarios, scientific caution was not upset by a lack of theoretical robustness which could have drawn critique but rather concern about estimates being potentially misunderstood. The sea level data available was part of a global dataset while sea level rise effects differ geographically. Hence, providing damage estimates on a granularity higher than the global level could have lead users of the data to assume a degree of precision not in fact provided by the global dataset – a legitimate concern shared by scientists outside of the research consortium (see e.g. Fiedler et al. 2021).

“So that was more like, we knew we could have used more data, but we didn’t want to use, didn’t want to put data there which could have been misused.” –

RC4, 19.07.2021

Thus, the scientist identity giving rise to the professional imperative of scientific caution – and not only models and their availability – explain the absence of key dimensions of physical climate reality from the central bankers’ imagination of climate futures. The need to insulate the science profession from criticism and politics hence created “a willingness to leave untouched the most important issues [sea level rise, physical damages affecting GDP growth rates, tipping points etc.] in order to deal objectively with those that can be adequately quantified” (Porter 1996, 229–30).

4.5.4. Risk management practice and operational imperatives

The professional imperative of scientific caution clashed with a different imperative in the context of the NGFS references scenario project: the operational imperative of basing decisions on precise and unambiguous numbers. The need for such precise and unambiguous quantification as basis for decision-making – independent of accuracy – is a product of late modernity and thus somewhat ubiquitous (Porter 1996). Financial risk management relies on quantification and calculative devices to an extraordinarily high degree (see e.g. Besedovsky 2018; Hall 2006; Millo and MacKenzie 2009), however, despite remaining differences in calculative cultures across financial institutions (Mikes 2009; 2011). This pre-existing practice of quantitative and precise risk management creates the operational imperative of increasing the granularity of climate risk data to match the resolution and precision of financial risk management practice needed at the operational level. Combined with the time pressure resulting from reputational imperatives, this has led the NGFS on a path of developing scenarios in depth rather than in breadth, e.g. limiting the number of scenarios to not overburden the

financial sector's operational capacity built for precision rather than broad imaginations of possible futures.

"And that's where so I think that this was a sort of thing that they've consistently been trying to gain a compromise between the academic committee going up, just keeping it to the three, four scenarios, that's, that's not good enough. It's not broad enough range' versus the, the financial sector go 'Well, we can only put in so many resources to this particular part with all the other legislation that you palm on us'. So it's got to be- So I think this was a compromise between the two viewpoints to be frank." – RC1, 23.06.2021

In an instance of instead enhancing granularity, macro-economic modelling is planned to be supplemented with sector-specific, so-called bottom-up, modelling to enhance the resolution of transition risk impacts. The striving for more granularity in turn poses two problems. First, increased precision can create a false sense of accuracy (Fiedler et al. 2021). This problem can become apparent during the development process as in the case of sectoral models deployed by the BdeF to increase their climate scenario analysis' granularity. These models produced outputs in conflict with the underlying NGFS outputs: According to the sectoral models, France does not reach carbon neutrality by 2050 in the NGFS' Net Zero 2050 scenario (field notes, 07.12.2021). Second, the constant effort to enhance granularity crowds out options to broaden the realm of imagined futures by taking imprecise and even non-quantified imaginaries into account. This affects not only bodies of knowledge possibly useful in instructing scenario development but completely absent from the NGFS reference scenario project such as political science – despite the fact that climate policy trends are considered a key risk driver – but also expertise represented in the research consortium.

"And um what's, what's then our, our safety net so to say, is, ok, we show the uncertainties in a transparent way, we take 3 different damage functions and 10 different climate sensitivities and say, alright, these are the boundaries. That's scientifically reasonable but for the users it's eventually not helpful at all or it makes it only more difficult to understand the whole thing and to take it in." –

RC15, 29.09.2021

"Tipping points we mentioned a few times but they [central banks] haven't quite grasped that yet. And, um, if we cannot provide anything concrete then it's difficult for central banks to understand anything really because if it's so vague that we say 'There are tipping points but we don't know them for many indicators'

then they say 'Well, great, they exist, but if we don't have numbers we can't do anything with that'.” – RC4, 19.07.2021

Thus, the operational imperatives of finance demanding precise, not ambiguous, and quantitative, not qualitative, imaginaries of climate futures contribute to the exclusion of certain elements of reality from the NGFS climate scenarios.

Financial sector practice introduced another operational imperative. To ensure the usefulness of the reference scenarios for financial practice, they could not become stress scenarios. With one exception (NGFS2), all central bankers interviewed found the NGFS reference scenarios to be either optimistic or 'central' estimates of future developments: For instance, perfect foresight is assumed in two of the three IAMs, market frictions from labour to capital markets are neglected, large parts of physical reality are excluded as outlined above, and so are recessions which are commonly part of a standard financial stress test.

These optimistic assumptions are partially artefacts of the IPCC process which was set up to develop optimal policy scenarios rather than stress scenarios but – due to the reputational imperatives discussed above – also became the basis for the NGFS reference scenarios. However, even within these limits of models computing optimal pathways rather than stress scenarios, central bankers decided to keep financial stress at moderate levels. While part of the reason might be the fear of bad press as publicly suggested by the BoE's Sam Woods (field notes, 21.06.2021), interviews indicate the reasons for this decision can also be found in the practice of using the scenarios.

“And like already, we got the feedback from so many sort of people in the financial sector, that assuming like 100% [default rate], or close to 100% here, in particular sectors means that those sectors are essentially just wiped out. So you almost like lose the value of the exercise by doing that. [...] We want them to both do, you know, have prudent central estimates for ways in which the world will evolve because that actually helps them think, 'Oh, yeah, I've got this client in the steel industry, and even under the most conservative central case, they're nowhere near aligned enough with net zero, I better have like a conversation with this client and understand what they're doing to prepare for this.' That's of so much more value than saying to a bank executive, you know, the steel industry is, is, is hit by, like 80% of their value added. [...] It means that that client defaults, but then the conversation kind of stops there.” – NGFS9, 09.09.2021

Thus, the imperatives arising from deploying the NGFS reference scenarios in practice on the operational level within financial institutions focused central bankers' imagined climate futures on

unambiguous numbers and on so-called ‘central’ estimates excluding respectively less precise knowledge and high levels of financial stress.

Summing up, the translation of climate futures into finance through the design of the reference scenarios had to pass through four OPPs linked by relationships of reliance, e.g. central bankers relying on scientists for reputational and legitimacy purposes while scientists relied on available models for feasibility and time-related reasons. While each OPP imposed specific imperatives onto the translation of climate futures, these imperatives interacted in their shaping of the scenarios, e.g. where the need for perceived neutrality in central bankers and scientists converge in instances of rendering political questions technical or where finance sector demands for precision and clarity conflict with scientists’ preference for caution. This implies agency within the scenario development process and hence responsibility for the current form of the scenarios does not lie with any individual actor (group) but with the actor-network arrangement.

4.6. Discussion

This section aims at contextualising this actor-network arrangement using two concepts helpful in situating the above findings vis-à-vis (alternative) futures and academic inquiries: the ontological politics of transformations induced by the translation process and the loose ends of translation chains.

4.6.1. Ontological politics

In some seminal ANT studies ontological politics are more intuitively accessible as changes to and object’s or a concept’s state can be immediately contrasted with a previously existing version, e.g. where a medical pathology changes from one version to another version of itself due to the utilisation of different measurements and definitions (Law and Mol 2001; Law and Singleton 2005; Mol 1999). Such transformations in the context of the NGFS reference scenarios primarily take place by translating abstract ideas of different climate futures into sets of models, assumptions, data inputs, and eventually model outputs. Instead of transforming a given object or concept into a different object or concept of the same type, imagining climate futures thus also involves the transformation of the type, i.e. of something abstract into something concrete. This makes ontological politics less visible as there is no immediate reference point for comparison to identify changes and differences. One response is to contrast individual elements of the NGFS scenarios with their counterparts deployed in other contexts, e.g. individual assumptions, model structures, and inclusions or exclusions of whole risk factors and risk transmission channels from sea level rise to climate-change-induced patterns of conflict and migration. Several of such partial alternatives to the reality of the NGFS scenarios have been flagged throughout the paper. However, the complexity of model cascades makes an exhaustive summary

impossible. Instead, general patterns or trends can be identified within the alternatives already covered.

Such identification is difficult, however, since what effects different assumptions or model structures might have is nearly impossible to gauge – not the least because central bankers envision quite different use cases for such scenarios ranging from a qualitatively analysing climate risk transmission channels to quantitatively gauging the size of different risk dimensions to eventually instructing capital requirements and investment strategies. An assessment of eventual effects is further complicated by interactions within and across models. For instance, while the omission of the financial sector in IAMs might lead to an underestimation of capital costs and thus transition risks, the notorious overestimation of renewable energy costs within IAMs (see e.g. Xiao et al. 2021) might counterbalance such an effect. Despite these uncertainties, the unimagined alternatives do suggest that the magnitude of both physical and transition risk might be grossly and structurally underestimated. From optimal solution pathways to the absence of recessions, capital costs, a just transition or the closure of certain highly emitting sectors and the omission of tipping points, alternative damage functions, and a wide range of physical hazards, it seems that a substantial number of factors relevant for wealth destruction and distribution have been left out of the central bankers' imagined climate futures.

Since those central bankers most closely involved in the development of the NGFS reference scenarios are acutely aware of the effects of the translation transformations, i.e. the low levels of financial stress, both the BdeF and the BoE adapted certain scenario assumptions to introduce higher stress levels in their national scenario exercises. These changes to the reference scenarios have so far not touched the fundamental design choices and thus still produce relatively moderate levels of imagined detrimental financial effects (see e.g. ACPR 2021; Bank of England 2022). Thus, while reducing comparability of climate risk assessment results across jurisdictions, the adapted scenarios still do not represent stress scenarios in the traditional sense. These low levels of stress could become particularly problematic where scenarios become black boxes (Latour 1987). While only a few European and North American central bankers continuously took part in the scenario development process and thus acquired a thorough understanding of it, central bankers from developing countries were only involved marginally and as passive users of scenario outputs requesting outputs rather than shaping the scenario design. The fact that the Hong Kong Monetary Authority, for instance, labelled their recent climate scenario exercise based on the NGFS scenarios a 'stress test' and depicted at least one of the scenarios as "extreme" (Hong Kong Monetary Authority 2021, 14 and 24) could be a first indication of such black boxing. Thus, reliance on the current version of NGFS scenarios in macroprudential supervision could in fact nurture the incubation (Vaughan 1999) rather than the management of risk and catastrophes. Several aspects of the scenario design process covered above match typical

characteristics of such an incubation phase: First, the exclusion of specialists and of readily available knowledge which does not fit the organisational habits of scenario production by the research consortium such as political science knowledge on environmental policies and diplomacy or knowledge on earth system tipping points. Second, “rigidities of core beliefs” (Power 2007, 10) such as the political neutrality of central bankers or the ideals of scientific practice of research consortium members keep the scenarios from becoming imaginations of plausible catastrophes.

These considerations lead into another layer of ontological politics focusing on the design process rather than individual elements of the NGFS scenarios. Where alternative realities, i.e. scenario development processes of similar calibre, are not readily available, a different strategy to make ontological politics visible is the development of counterfactual narratives (see e.g. Allan 2017; Latour 2005, 79–82). Literature on the production of risk- and climate-related knowledge points to the practical and epistemological value as well as the ethical desirability of democratizing such processes in the sense of increasing the diversity of academic disciplines and specialists included, types of knowledge incorporated, and transparency ensured (Jasanoff 2013; Maechler and Graz 2022; Power 2007, 15–16). Thus, an alternative to the scenario design process followed by the NGFS could involve a diversification of methods and outputs such as, e.g. a more qualitative exploration of how food insecurity induced by climate change can trigger societal collapse (Richards, Lupton, and Allwood 2021). Other academic specialists such as political scientists could be involved in the design of climate policy assumptions to bring decades of research that does not fit into the codes of IAMs to bare on how finance imagines its climate futures. While the final products of such an inclusive scenario design process cannot be predicted, it seems plausible to assume the scenarios thus designed would map a wider scope of possible futures including both imagined catastrophes of societal collapse and positive imaginaries of societal prosperity beyond capital accumulation. In both cases, however, financial stress could significantly exceed the levels produced by the current NGFS scenarios.

4.6.2. Loose ends of translation

Only a fraction of the ontological politics underlying the NGFS scenarios can be unearthed in a paper focusing on the immediate design phase. For instance, this paper did not cover the choices made and contestations closed down to build macro-economic DSGE models which are widely used in central banking despite continuously failing to predict economic developments (Beckert 2016, 221–27; Hendry and Muellbauer 2018). This model type, however, is part of the NGFS scenario model cascade and hence a loose end in the translation of climate futures. Equally, the questions around ‘downstream’ translations of the NGFS scenarios into financial supervision activities raised above cannot be addressed in this paper and thus constitute loose ends of the translation process.

While stopping to trace translation and thus ontological politics is a political decision within the research process, ANT does not provide much orientation on how to navigate such decisions. As Law and Williams (2014, 23) put it, “STS [Science and Technology Studies] is very good at tracing [...] networks, and less good at knowing when to stop”. Since the question of when to stop is a practical one partially dictated by the resources available to the researcher, instead of theoretically discussing it, this paper suggests a basic framework to map and thus make explicit the loose ends necessarily part of any ANT study. The framework is inspired by the concept of political situations applied by Barry (2012) to the issue of knowledge controversies in transnational governance and aims to map out historical loose ends preceding the NGFS scenario design and future loose ends following it.

Barry suggests that STS tends to approach knowledge controversies as isolated cases focusing on their specificities rather than on trends and historical continuities (Barry 2012, 329). In the context of this study, it highlights open questions around similarities or differences between imperatives shaping the NGFS scenarios and imperatives structuring knowledge controversies around GCMs, IAMs or the data bases of scenario pathway assumptions developed for and by the IPCC all feeding into the NGFS scenarios. It also poses questions on potential similarities to how knowledge controversies unfold and are closed down in processes of imagining climate futures not directly connected to the NGFS scenarios such as the development of IEA or International Renewable Energy Agency scenarios. For instance, the rarity of climate scenarios based on maximising measures of well-being rather than maximising GDP or minimising monetary costs seems to be a widespread trend posing the question what the boundary conditions are that structure so many imaginations of climate futures.

Governance arrangements – whether it’s the IPCC or the NGFS – do not only close down or resolve knowledge controversies, as Barry notes, but also create new ones. The development of the NGFS scenarios making climate scenario exercises within finance possible creates a range of choices around the conduct of such exercises, the interpretation of results, and the implications for financial supervision. With financial industry associations already positioning themselves against translating scenario exercise results into regulatory requirements due to inherent uncertainties of said scenarios⁹ and some finance professionals depicting the NGFS scenarios as designed “to obtain alarming results” (Agnew, Mundy, and Morris 2022), knowledge controversies around the imagination of climate futures within finance are only just beginning. How the different translation imperatives and their effects instructed further controversies, mirror them, or are ignored to advance the strategies and goals of

⁹ [Principles for the effective management and supervision of climate-related financial risks | American Bankers Association \(aba.com\)](https://www.aba.com/Principles-for-the-effective-management-and-supervision-of-climate-related-financial-risks) and [fsf---bcbs-climate-risk-principles-comment-letter.pdf \(fsforum.com\)](https://fsforum.com/fsf---bcbs-climate-risk-principles-comment-letter.pdf) [last accessed on 25.03.2022].

different actors involved goes beyond the scope of this study but constitutes a loose end of significance for the future of financial supervision, financial stability, and climate stability.

4.7. Conclusion

Climate change constitutes for finance but also for societies at large a ‘tragedy of the horizon’ (Carney 2015) in the sense that once the effects of climate change can be understood with a high degree of precision and confidence it will be too late to avoid them. Bringing climate futures into the present via imagination to break this tragedy is thus a key step in avoiding climate catastrophes. This paper traces the translation of climate futures into operational climate scenarios by the NGFS. Employing the concept of obligatory passage points it highlights the reputational, technical, professional, and operational imperatives defining the ontological politics which shape how climate futures are imagined within finance. Conceptually, the paper thus demonstrates the value of bringing concepts from the sociology of translation into the study of imagining futures across disciplines from economic sociology to organisation studies. Empirically, it contributes to emerging literatures both on scenario modelling as key practice and on central banks as new actors in climate governance (Garb, Pulver, and VanDeveer 2008; Langley and Morris 2020; Pulver and VanDeveer 2009; VanDeveer and Pulver 2021). In sum, the paper wants to demonstrate that the NGFS scenarios and thus perhaps more generally translations of climate futures are not exclusively shaped by the boundaries of available knowledge or the configurations of certainties and uncertainties within science. Rather, organisational parameters, pre-existing technical arrangements of models and data as well as legal and ideational structures play a role in selecting or excluding alternative imaginaries of climate futures. By unveiling those ontological politics, this paper facilitates both critique and alternative imaginary futures.

Far from comprehensive, this paper merely scratches the surface of how finance imagines its climate futures. The various loose ends of historical and future translations of climate futures call for a multi-disciplinary engagement with questions of model and scenario design, implementation, and effects. The heterogeneity and plurality of localities in which finance’s climate futures are and will be imagined, probed, and performed – ranging from publicly funded research centres to commercial consulting service providers and from central banks’ macroprudential supervision teams to banks’ risk functions – needs to be matched by heterogeneous and plural research approaches. Accompanying research to the imagination of climate futures is not just a promising academic endeavour. It is also a potential avenue to aid reflexivity in practice and keep the tragedy of the horizon from extending into a tragedy of translation where the imagination of climate catastrophes is avoided rather than climate futures being imagined help to avoid catastrophes.

Appendix A: List of observed events

Title	Host	Type of event	Date & location
Macroeconomic and Financial Stability Implications of Climate Change	Bank of England	In-person conference	Jan 29, 2019, London
UNEP FI Global Roundtable 2020	UNEP FI	Online conference	Oct 13, 2020, virtual
Paris Climate Finance Day 2020	Climate Finance Day	Hybrid conference	Oct 29, 2020
The Exposure of Financial Institutions to Risks from a Transition to a Carbon Neutral Economy	NGFS / INSPIRE	Online workshop	Nov 4, 2020
Climate Change: An Analysis of the NGFS Macroeconomic Scenarios	NIESR	Online workshop	Nov 25, 2020, virtual
Physical Risk Workshop 1: Damages induced by extreme weather events	NGFS / INSPIRE	Online workshop	Dec 7, 2020, virtual
Physical Risk Workshop 2: Macroeconomic damages	NGFS / INSPIRE	Online workshop	Dec 16, 2020, virtual
The role of different methodological approaches in climate change macroeconomics and green central banking	PIK / Bundesbank / INSPIRE	Webinar	Apr 21, 2021, virtual
The Green Swan Conference – coordinating finance on climate	BIS / Banque de France / IMF / NGFS	Online conference	Jun 2-4, 2021
City Week 2021 – climate risk scenario planning	City & Financial Global Ltd.	Online conference	Jun 21, 2021, London/virtual
ISIPEDIA Climate Impact Information Workshop	Climate Analytics	Online workshop	Jun 24, 2021, virtual
OMFIF Sustainable Policy Institute Symposium – Revolutionising finance for net zero	OMFIF	Online conference	Sep 29, 2021
PRI Digital Conference – the Inevitable Policy Response to climate change	UN PRI	Online conference	Oct 19, 2021, virtual
The macro-financial impacts of climate change and the net zero transition	Banca d'Italia / Bank of England	Hybrid conference	Oct 19-20, 2021, Rome
Green Finance Research Advances	Banque de France / Institut Louis Bachelier	Hybrid conference	Dec 7-8, 2021, Paris

Table 7: list of observed events

Appendix B: Interview question blocks

Question block	Description
<i>Recruitment of Research Consortium members (NGFS members only)</i>	How and why different members were recruited
<i>NGFS interactions (Research Consortium members only)</i>	What characterised interactions with the NGFS

<i>Model structure</i>	Questions of understanding on the components and ways of working of the model in question
<i>Design choices & assumptions</i>	What and how design choices and assumptions were made, how they affect outputs, and where disagreements or other problems occurred
<i>Uncertainty</i>	Where sources of uncertainties lie, how these uncertainties are being treated, and how they are being perceived by the interviewee
<i>Motivation & goals</i> (NGFS members only)	What the motivation and goals for developing climate scenarios are

Table 8: interview question blocks

Appendix C: First set of codes

Code	Definition
<i>Anschlussfähigkeit</i>	Accounts of (lack of) fitness or suitability of something or someone to link to or be useful to someone or something else
<i>Belief in markets</i>	Accounts that contain some belief in the ideal functioning of markets, e.g. market discipline
<i>Caution</i>	Statements on caution guiding choices/decisions
<i>Emotions & feelings</i>	Expressions of emotions, sentiments, and feelings
<i>Expertise</i>	Statements on expertise
<i>Feasibility</i>	Feasibility as driver of decision-making
<i>Financial sector</i>	Statements on the role of the financial sector in the scenarios
<i>Indecisiveness</i>	Accounts of situations in which decisions were not made
<i>Models</i>	Accounts of models resisting, shaping scenario choices etc.
<i>Neutrality</i>	Statements on the neutrality and objectivity of central banks or scenarios
<i>Numbers</i>	Accounts of the meaning, accuracy, or effect of numbers
<i>Openness & transparency</i>	Statements on how NGFS is open to feedback and values transparency of the scenario assumptions and models
<i>Path dependency</i>	Statements on path dependencies
<i>Reputation</i>	Statements on the importance of reputation
<i>Standardization</i>	Statements on standardization of scenario analysis
<i>Stress</i>	Statements on the level of stress captured in the scenarios
<i>Time constraints</i>	Accounts of time constraints affecting the scenario design process

Table 9: first set of codes

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5. For a sociology of climate risk

Abstract

This paper develops a research agenda for an inclusive sociology of climate risk. In doing so, it calls for a broader sociological engagement with climate risk, outlining how the Callonian concept of economization (Çalışkan and Callon 2009) can integrate an institutional and a material approach to climate risk. It considers, first, the complex institutional work that went into making climate change legible to financial actors. With the construction of climate risk today primarily taking place in the forums of mathematical modelling and calculation, the paper then turns to models. Drawing on the social studies of finance, the paper underscores path dependencies, silo formation, and performativity as key socio-technical dynamics surrounding climate risk modelling in need of investigation. Finally, we lay out how Callonian economization can integrate an institutional and a material perspective on climate risk, identifying areas of research on the institutional antecedences of model design, the effects of large-scale model deployment, and alternative problematizations of climate change. The paper illustrates and emphasizes the need to mobilize the full spectrum of sociological expertise – from development to political and economic sociology – to understand and critique this phenomenon fundamentally reconfiguring how finance and the planet's climate relate: climate risk.

5.1. Introduction

Since April 6, 2022, more than 1,300 of the UK's largest companies and financial institutions are being required to disclose climate-related risks, meaning the expected effects of higher average temperatures, or of changes resulting from the transition to a lower-carbon economy. While the UK was among the first to introduce climate risk reporting requirements into law, it did so following the recommendations of an international organization set up by the G20's Financial Stability Board (FSB), the Task Force on Climate-related Financial Disclosures (TCFD), which informed similar policy changes in the European Union, Brazil, and across the world (TCFD 2021a). Furthermore, the new requirements come in the wake of a wave of climate scenario exercises – often dubbed climate stress tests – testing how financial institutions' balance sheets fare under different climate scenarios starting in France and currently spanning 15 different jurisdictions from Mexico to Japan (NGFS 2021). Taken together, these changes are intended as a substantive form of government intervention to make the financial system responsive to climate-related issues, supporting a world-wide capital market adaptation to global warming.

An emerging body of literature drawing from a range of social science disciplines has started exploring these dynamics unfolding around the issue of climate risk. Langley and Morris (2020) identify central banks positioning themselves as technocratic climate governors by starting to supervise climate risk in the financial system. By highlighting the tool of climate stress testing, the authors call for a critical inquiry of such technocratic engagement with climate change by central bankers. Christophers (2017) critiques the framework for climate-related financial disclosure developed by the TCFD which – according to the author – presents a 'neoliberal modality' of governance rooted in unrealistic assumptions about efficient markets, market actors' rationality, and the calculability of future climate events. Christophers (2019) also critiques the integration of climate risk into investment practices as not affecting capital allocation to fossil fuel companies due to conventions, short time horizons, and inadequate analytical tools. Elliott (2021) shows further limits of a climate risk approach: the technocratic re-definition of climate risk in the form of new flood maps in New York City exposes affected residents to higher insurance premia spurring social resistance against and eventual abandonment of the new tool (see also Gray 2021).

However, existing accounts of climate risk have not yet fully accounted for the process that turns a societal problem, climate change, into a problematic neoliberal and technocratic project. In other words, how is it that the world ended up stuck with a financial solution to climate change that is undemocratic (Langley and Morris 2020) and ineffective (Christophers 2017; 2019)? While both Christophers and Langley & Morris identify the loci of control over climate risk – the FSB and central banks – neither account for the actions and processes turning the political issue of climate change into

an economic issue to be dealt with in these respective loci. The current problematic approach to climate risk thus appears inevitable in the case of Christophers and inexplicable in the case of Langley & Morris. Alternative projects, roads not taken, and points of resistance thus become obscured. What is needed, in other words, is scholarly engagement with climate risk that recognizes the institutional work that went into the present climate risk tools and institutions, identifies existing points of contestation, and points of possible interventions. In addition to this shortcoming, an underdeveloped potential of this literature requires scholarly work. Christophers' disclosure framework and discounted cash flow models, Elliott's flood maps, and Langley & Morris' climate stress tests all highlight the central role of frameworks and calculative tools in constituting a climate risk regime. While Langley & Morris flag the interconnectedness of such tools and field-level dynamics, their commentary calls for their further exploration rather than providing conclusive arguments. Thus, at the heart of both Christophers and Langley & Morris lies not only a static account that overlooks the institutional process whereby climate change becomes economic but it also insufficiently conceptualises the material dimension of tools layered into this process.

How can sociologists approach the process of climate risk construction with a sensitivity to both its technocratic tool-centred character and its embeddedness in a contingent socio-political history of institutions and institutional work? We call for a research agenda guided by this question. Outlining key pillars of the institutional work that proved pivotal to rendering climate change economic, the paper challenges the inevitability of the present of a technocratic and neoliberal tool-focused approach. Accounting for the central role of technical tools, we underscore path dependencies, silo formation, and performativity as key socio-technical dynamics surrounding climate risk modelling needing investigation. Lastly, the paper lays out the potential of economization to integrate scholarly inquiry of climate risk along three dimensions. First, the intergovernmental politics such as the UNFCCC COPs preceding and delineating the current state of climate risk modelling. Second, the socio-economic and political relations effectively (re-)produced and extended through the use of climate risk models. Third, the alternative non-economic problematizations of climate change such as the planetary boundary conception currently ignored or rejected within finance. With these three moves of thinking climate risk as economization – in terms of history, modelling, and an integrative conceptualisation – we develop a research agenda calling for numerous sociological sub-disciplines to bring their respective analytical skills to bear on this phenomenon fundamentally reconfiguring how finance and the planet's climate relate: climate risk.

5.2. The rise of climate risk

What is climate risk and how did it achieve the significance within finance that it has today? The rise of climate risk within finance does not follow a linear or unavoidable diffusion path. It rather presents

itself as a laborious effort by institutional entrepreneurs creating tools to facilitate the measurement of climate risk as well as organisations and networks actively pursuing the arguing, convincing, and negotiating necessary to disperse the idea that climate risk does exist and is relevant for the financial sector. It signifies a move of the issue of climate change from the frontiers of finance into its homeland.

Arguably, the concept of financial climate risk was born in 1994. Starting in the late 1980s, the environment increasingly moved into the spotlight of some financial market actors driven by two factors. On the one hand, environmental disasters such as the Exxon-Valdez oil spill of 1989 highlighted the financial implications of environmentally harmful corporate activity. On the other hand, policy action on climate change started becoming global and more credible with the creation of the UN Framework Convention on Climate Change (UNFCCC) in 1992 and the negotiation of the Kyoto Protocol in 1997. Keen observers very early on realised that such political action could have profound financial implications. One of the first reports flagging the overvaluation of fossil fuel companies given the need to reduce fossil fuel consumption to mitigate climate change was published as early as 1994 (Mansley 1994). Thus, climate change became explicitly related to financial valuation. However, as Mark Campanale, one of the early proponents of climate risk recalls in an interview, despite the concept of climate risk thus being in the public domain it did not gain traction.¹⁰

In the early 2000s, however, climate risk came to be endorsed and promoted by the UN system and sustainable finance NGOs. In 2003 the first Institutional Investor Summit on Climate Risk was co-hosted by the UN and Ceres, an NGO based in Boston, MA, promoting sustainable finance. The risk frame was typically used as vehicle to put sustainability issues onto the agenda of financial market actors. Indeed, the legal structures governing investment practices typically require the unconditional prioritisation of monetary gains over any other possible goal. Thus, climate had to be framed in a way furthering this very goal of monetary value creation for the asset owner, i.e. it had to be shown to be in line with the legal fiduciary duties of an asset manager. The UN as organisational vehicle and convenor played another key role in overcoming this barrier for climate risk by initiating a re-interpretation of fiduciary duties with its initial so-called Freshfields Report (Freshfields Bruckhaus Deringer 2005) and its later programme named Fiduciary Duties in the 21st Century (see e.g. PRI and UNEP FI 2019). Outside of the UN sphere, the concept of 'financial materiality' was extended to capture financially relevant climate-related issues for reporting purposes by organisations like the Sustainability Accounting Standards Board (SASB) founded in 2011 in the US.

The continued institutionalisation of climate risk took several forms. Following the organisation of the UN investor summits on an annual basis, the creation of the Investor Network on Climate Risk out of

¹⁰ <https://carbontracker.org/when-i-was-a-teenager-i-had-these-terrible-nightmares-that-the-world-was-on-fire-reflections-from-mark-campanale-and-nick-robins/> [29.07.2021].

these UN summits, and thus overall, an increasing momentum, financial market regulators and supervisors started to slowly become active on climate risk as well. For instance, in 2010 the US Securities and Exchange Commission (2010) issued guidance on the disclosure of climate-related risks by publicly traded firms. While not constituting a watershed moment in the history of climate risk (see e.g. Deatherage 2011), this official supervisory engagement contributed to the legitimisation of thinking and action around climate risk within finance. A further milestone on the level of discourse was the publication of a report by the Carbon Tracker Initiative (2011) coining many of the terms that would shape the debate over the following years such as 'unburnable carbon' or the 'carbon bubble'.

A tipping point was reached at COP21 in Paris in 2015. In an effort to mobilise financial markets for climate change mitigation, the French COP team used the climate risk narrative to obtain a G20 mandate for the Financial Stability Board (FSB) since risk management sits at the core of the FSB's legal mandate. The FSB was set up by the G20 as a stronger version of its predecessor – the Financial Stability Forum – after and in reaction to the global financial crisis which exposed shortcomings in global financial market supervision (Helleiner 2010; Mackintosh 2017; Moschella 2013). Chair of the FSB at that time was Mark Carney who, as Governor of the Bank of England (BoE), had already started investigating climate risk in the UK insurance sector (PRA 2015) after an invitation by the UK government to explore climate adaptation needs within the Bank. Hence, he was receptive to this new mandate. After a landmark speech on climate risk at Lloyd's of London (Carney 2015), Carney announced the creation of an FSB Task Force on Climate-related Financial Disclosures (TCFD) at COP21 in Paris. The combined events of the Paris Agreement which was widely perceived as a watershed moment in tackling climate change (Christoff 2016; Dimitrov 2016; Falkner 2016) and the official announcement of the TCFD further legitimised climate risk as an issue deserving attention within mainstream finance.

The TCFD developed such an effect due to its authority awarded by the backing of the FSB, the membership of some of the largest financial institutions as well as of carbon-intensive companies, and the facilitation by the Big Four Accounting Firms, Bloomberg, and former SEC Chair Mary Shapiro. The fact that the TCFD in its final recommendations stated that climate-related disclosure belonged into the financial filings if climate risks were material transformed climate from a CSR topic to an issue at the heart of financial valuation.

The collective work of legitimising climate risk by the Bank of England, Mark Carney, and the TCFD also spelled out two main categories of climate risk: transition risk and physical risk. The former relates to impacts resulting from a transition towards a lower-carbon economy whether due to climate policies, technological change or changing consumption patterns. The latter refers to the biophysical impacts from climate change such as extreme weather events, sea level rise or chronic draughts. The Bank of

England's first climate risk report (see PRA 2015) specified a third climate risk category, namely litigation risk resulting from climate-related law suits. However, subsequent reports by the TCFD have subsumed this third risk category and thus de-emphasized it (see TCFD 2017; 2021a), possibly out of self-fulfilling prophecy concerns.

Since the Paris Agreement, regulatory and supervisory action on climate risk has accelerated. Since December 2018, the Network on Greening the Financial System (NGFS) – a group of central banks and supervisors – hosted by the Banque de France has predominantly focused on climate risk (see e.g. NGFS 2018; 2019) and has grown from its originally eight members to the size of over 100. Since September 2020, nation states have been announcing the translation of the TCFD's global recommendations into national law with New Zealand, the UK, and Switzerland among the first movers (TCFD 2021a). Climate risk is now being introduced into micro- and macro-prudential supervision through what is colloquially called climate stress testing, that is an assessment of how financial institutions fare under different climate scenarios (NGFS 2020; 2021). Central banks are by now even discussing how to integrated climate risk considerations into monetary policy (see e.g. Coeuré 2018). These developments are particularly significant due to the growing importance of central banks in global finance since the 2008 financial crisis (Langley and Morris 2020; Mackintosh 2017; Tooze 2021). In parallel, the private sector has been integrating climate risk into product designs. For instance, the stock index provider S&P Dow Jones is now providing "carbon exposure metrics" such as carbon footprint, carbon efficiency, weighted average carbon intensity, and fossil fuel reserves metrics in its indices to clients for integrating climate risk into their decision making (S&P Dow Jones Indices 2020). Enterprises now even structure their whole business models around climate risk as in the case of Carbon Delta, a climate risk data provider founded in 2015 specialised on climate scenario analysis.

Given the above, most major financial institutions now measure their climate risk exposure. As part of that, transition risks are typically assessed directly or indirectly using some type of Integrated Assessment Model (IAM) that links multiple specialised models such as energy system and land use models, macro-economic and simplified climate models in order to generate pathways toward a certain temperature goal, e.g. 1.5°C warming by the year 2100. IAMs have been designed to produce climate scenario pathways not for financial markets but for the assessment reports of the Intergovernmental Panel and Climate Change (IPCC) (Cointe, Cassen, and Nadaï 2019). Hence, they do not provide risk figures for specific financial assets as outputs but rather generate data on e.g. GDP, energy usage, the size of certain sectors etc. In the context of the energy sector, the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA) provide often used scenarios more specific to this individual sector. Scenario outputs are used for subsequent economic and eventually financial risk analysis producing values for metrics such as probability of default (Allen

et al. 2020; Carlin et al. 2021). The calculation of physical risks differs in its organisational nature in so far as parts of it have been practiced for many years on the underwriting side of the insurance sector. Typically, physical risks are assessed with a series of models generating, first, temperature pathways via climate models, second, climate impacts at certain temperature levels using e.g. hydrological models in the case of flooding, and, finally, economic damages resulting from said impacts using so-called damage functions.

Thus, both in the case of physical and transition risk a multitude of models from climate to economic models supply data to the next model in line – often in concert with other models of the same type to account for model-related uncertainty. While other financial risks are typically calculated within the organisational boundaries of a financial institution, the calculation of climate risk is distributed across multiple types of models developed and run by different organisation and often for different purposes unrelated to financial risk assessment. All these modelling approaches remain incomplete, are constantly being extended and advanced, and are characterised by a degree of opacity and a lack of standardization (see e.g. Bank for International Settlements 2021; Battiston et al. 2021; Bertram et al. 2021). Typically perceived as most sophisticated attempts to gauge climate risk, they have emerged as the new arena within which climate risk within finance is being constructed.

This account of the rise of climate risk helps to orient a sociology of climate risk empirically: Since climate risk models now constitute such a key site for the construction of climate risk, they present themselves as natural starting point for empirical in-vivo sociological inquiry.

5.3. Modelling pitfalls in climate risk assessment

As sociologists have shown, models can prove ineffective, counterproductive or have unintended consequences due to the social context in which they are used – including unexpected feedback loops, organizational siloes, or self-fulfilling prophecies. By drawing on the social studies of finance literature this section outlines how a sociological engagement with climate risk can illuminate how social dynamics shape climate risk modelling. As other scholars have noted in the cases of Black Scholes, the Gaussian Copula or Value at Risk, one central claim in this section is that the socio-technical context of any risk assessment can impact on and introduce limitations at any stage of the modelling life cycle: the design, the adoption, the implementation, and performative implications.

5.3.1. Design

Intuitively, the design phase of any risk assessment framework, device, or tool is critical as it sets parameters and creates path dependencies affecting every other stage ‘downstream’ of both risk assessment and risk management. Paradoxically, however, the design stage can become the least visible, most black-boxed stage. Limitations and biases introduced at this stage can therefore easily

become dormant time-bombs. Enterprise Risk Management (ERM) is a case in point. As Power (2009) argues, assumptions and preferences built into the most common types of enterprise risk management by the auditing and accounting profession co-facilitated the systemic failures within financial institutions to adequately identify and manage risk prior to the global financial crisis in 2007/8. First, the homogenisation of risk appetite within an enterprise veiled the dynamic and divergent nature of risk appetites within different segments of an enterprise. Second, the focus on auditable aspects of risk created a sense of safety and security while systematically neglecting more challenging and ambiguous approaches to risk management such as scenario analysis. Third, risk management is limited to the entity-level relevant for accounting practices. This makes it blind to the dependencies of a firm on its wider context, e.g. on the financial health of peer institutions or the stability of the climatic system.

The above is relevant for sustainable finance as well. Just like assumptions about an entities nature and preferences towards auditability inherently limit risk management, tools in the space of sustainable finance are shaped and bound by the socio-technical contexts in which they were designed – their “social origins” as Eccles, Lee, and Stroehle (2020) call it. These social origins of one of the most widely used sustainability data tools – the KLD and later MSCI ratings – in fact changed its very goal and make up. The need to cater to the needs of clients, for instance, led to a methodological focus on scalability rather than on e.g. theoretical soundness or accuracy. In sum, as Eccles, Lee, and Stroehle (2020, 575) point out, “different origins, philosophies, and 'purposes' of ESG issues shaped the methods and data characteristics of two of the most important data vendors of their time.”

Given the nascent character of climate risk analysis, many if not most questions on design are still being debated. Ongoing controversies revolve around, for instance, Integrated Assessment Models (IAM), which are at the heart of many climate risk assessments (Beck and Krueger 2016; Ellenbeck and Lilliestam 2019). Assumptions and modelling choices underlying IAMs are being criticised prominently (DeFries et al. 2019; Pindyck 2013; Stern 2013; 2016): What is the appropriate rate at which to discount, i.e. ‘devalue’, the future? Similar debates surround the energy system scenarios published by the IEA which serve as critical input into many climate risk assessments (Mohn 2020): Will the steep price decline in renewable energies continue (Xiao et al. 2021)? Since the outcome of these controversies significantly shape model designs and outputs, sociologists need to interrogate how these controversies are settled.

This need becomes even more pressing in the context of climate risk tools already being black-boxed with, for instance, their design (and the controversies around them) hidden behind the walls of proprietary models. This black-boxing can be functional. Given the combination of the urgency of the climate crisis, increasing pressure from central banks and financial supervisors to manage and disclose

on climate-related risks, and the general lack of climate expertise within financial institutions and supervisory bodies (Fiedler et al. 2021), strong incentives to not second-guess design choices are in place.

In addition to mathematical models, the design of climate risk disclosure frameworks is another prime area for sociological scrutiny. Such frameworks aim at providing agreed upon principles instructing disclosure practice. Since such principles are derived from pre-existing frameworks, they might carry unsuitable assumptions with them potentially leading to unintended consequences. Such effects of translation processes call for sociological engagement. Climate risk disclosure, while still in its infancy, with governance structures defining its shape still emerging, has already centred around one single framework: the TCFD recommendations, which are currently the most widely endorsed framework for climate risk disclosure and are set to form the basis for mandatory disclosure across the G20 and beyond (see e.g. TCFD 2021a). This framework closely follows tenets and logics from the financial accounting space. For instance, the principles that are recommended as underpinning climate-related disclosure are nearly identical with those issued by the Enhanced Disclosure Task Force (EDTF) on financial disclosure in banking which also served as organisational blueprint for the TCFD (see EDTF 2012; TCFD 2017).

This analogical relationship between climate risk disclosure and traditional financial accounting standard setting could potentially become problematic if principles imported from financial accounting obscure uncertainties and trade-offs in the context of climate risk disclosure. For instance, the principle of completeness currently cannot be fulfilled by any company in terms of physical risk disclosure due to the technical constraints of climate models, which cannot resolve on a weather scale, i.e. they cannot predict specific extreme weather events – those events that constitute physical risks (see e.g. Fiedler et al. 2021). Equally, the highly stylised modelling of transition risk within IAMs cannot be considered complete assessments e.g. due to their systematic neglect of key risk drivers such as consumer preference changes (Bertram et al. 2021; DeFries et al. 2019; Stern 2016). These issues could potentially become problematic if by developing disclosures and disclosure frameworks with the goal of and belief in achieving complete disclosure (e.g. by striving for greater computational power), an engagement with the necessarily remaining incompleteness in climate risk modelling becomes neglected.

In addition to these potential obscuring effects, trade-off between different disclosure principles might exist in the climate disclosure context. For instance, there might be tensions between the principles of comparability on the one hand and relevance on the other hand: To facilitate comparability, forward-looking climate-risk analysis would need to be sufficiently standardised, e.g. along the lines of the reference scenarios developed by the NGFS. For meaningful and relevant climate risk analysis,

however, such scenarios and modelling should be specific to a company. In sum, there is a risk of (unintentional) misuse of climate-related data instructed by financial accounting assumptions. Thus, sociologists of climate risk disclosure need to engage with the obscuring effects and trade-offs discussed above by tracing their respective implications and origins as well as empirically identifying additional tensions.

More fundamentally, these limitations and trade-offs pose the question to what degree disclosure is an adequate governance tool to tackle climate risk in the first place. As Christophers (2017) has noted, the Knightian pre-condition of risk-based decision-making (as opposed to uncertainty-based) is so clearly so far out of sight, risk management through price signals and market discipline seems to be utterly insufficient (for similar arguments by ecological economists see Chenet, Ryan-Collins, and van Lerven 2021). To Christophers, disclosure became the policy tool of choice due to institutionalised neoliberal ideas. Beyond Christophers and assuming disclosure was the best policy tool, whose information needs should be addressed through a disclosure framework – actual investors, imagined investors, regulators, the public (see Preda 2005)? Thus, questions within the research agenda for a sociology of climate risk should not just ask about socio-technical configurations such as those surrounding IAMs but also the institutionalised frameworks that informed the TCFD. What were the rationales, motives, and drivers to approach climate risk from a disclosure angle? To what degree do these drivers distract from solutions more fitting to the problem of climate risk?

As disclosure frameworks develop into accounting standards, questions arise around worth and value. As Stark (2009) argued, the problem of what counts as value is central to markets and economic sociology. This question of worth manifests in the definition of financial materiality, i.e. the definition of what information is deemed relevant for investors. In the case of climate risk, this definition is currently being delegated to the International Sustainability Standards Board (ISSB) created in 2021 by the IFRS Foundation which is setting financial accounting rules in about 120 jurisdictions. The ISSB's understanding of materiality currently only includes information on the effects of climate change on the disclosing entity and not vice versa; this is denoted as a single materiality rather than a double materiality approach called for by some financial regulators and central bankers (see e.g. Oman and Svartzman 2021; Taeger 2021). With Botzem (2012) noting that the IFRS Foundation has traditionally been heavily dominated by accounting elites from the Big Four accounting firms, the question arises whether the ISSB's definition of materiality has been subject to similar influences. Formulated more broadly, sociologists of climate risk should inquire into the social determinants of worth in the context of accounting standards.

5.3.2. Adoption

While the previous section is concerned with model, framework, and standard design, there is a second stage in the construction of climate risk: the adoption of models and tools. The adoption of practices and standards have been exhaustively examined by a vast body of literature in institutional sociology. This has shown that such adoption is chiefly a function of legitimacy rather than accuracy (DiMaggio and Powell 1983; Strang and Meyer 1993; Tolbert and Zucker 1983). In the case of models, an established body of research in the social studies of finance has adopted a micro-level perspective and shown that an actors' adoption of a risk model does not exclusively depend on its accuracy but on its broader usefulness (MacKenzie and Spears 2014; Millo and MacKenzie 2009). This often turns on how well a model fits into the pre-existing socio-technical arrangements or facilitates tasks that are parallel to modelling such as compensation, supervision, or communication. The disturbing implication is that markets may end up adopting inaccurate climate risk models.

The seminal contribution to the model accuracy vs. usefulness debate is Millo and MacKenzie's (2009) study on the diffusion of the Black Scholes expression used in option pricing. A critical factor in this widespread adoption was that the Black-Scholes proved useful in a *separate* context, namely risk management. In risk management, Black-Scholes allowed for clearer communication within trading organizations, reducing the complexity of the necessary financial data, and thus leading to more efficient decision-making. Similarly, applications of Black-Scholes addressed the operational challenges faced by financial exchanges in their control function, which needed to quantify risk. Finally, the growing consensus among market participants around the usefulness of Black-Scholes helped the regulator legitimize its own decisions. In sum, "the remarkable success of today's financial risk management methods should be attributed primarily to their communicative and organizational usefulness and less to the accuracy of the results they produced" (Millo and MacKenzie 2009, 638).

Similar dynamics have been documented leading up to the global financial crisis of 2008. At the time, the Gaussian Copula was the mathematical expression used to estimate the correlation risk among the mortgage-based securities comprising the now-infamous collateralized debt obligations, or CDOs, associated with Wall Street's meltdown in 2008. Correlation risk was the critical problem missed by American rating agencies, leading to inaccurate risk estimates and mounting losses for Wall Street and the City of London (Salmon 2009). MacKenzie and Spears (2014) established that the Gaussian Copula was in fact adopted despite substantial reservations about its accuracy. Indeed, the formula diffused because it made possible for the profits of a derivatives deal – which could accrue for up to ten years – to be recognized in their entirety as soon as the deal was done, boosting the traders' bonus for that year.

The adoption of inaccurate models can also be indicative of a lack of calculative skills (broadly construed as by Callon, Méadel, and Rabeharisoa 2002). Beunza and Ferraro's (2018) analysis of a data vendor is illustrative in this regard. Given its dominant market position, the company's original plans for its ESG product initially presumed that including ESG data in its own platform would ensure widespread diffusion. However, the ESG product lacked the simplifying features offered by its competitors, including ratings of ESG performance. Hence, after a number of years of very limited diffusion, it became clear to the company that ESG investors lacked the skills to arrive at investment decisions purely on the basis of raw data, and that simplified ESG ratings were instead necessary.

The above has profound implications for the assessment of existing climate risk metrics and models. If the market is thought of as best mechanism for valuation in the form of so-called price discovery, the market should be equally successful at identifying the best tools to facilitate such valuation, i.e. risk metrics and models. Financial sociology does not only challenge this notion but also shines a light on the organisational dynamics and mechanisms co-shaping the selection of metrics and tools and thus the formation of market practice.

The use of certain climate risk metrics is a case in point. The perhaps greatest controversy has been around carbon intensity metrics. These are composite measure dividing absolute carbon emissions by other entity-specific indicators such as output, revenue, profit or asset value (PCAF 2020; S&P Dow Jones Indices 2020). While the TCFD itself recommended the use of such metrics in its original report from 2017, it simultaneously flagged the main problem of their use (TCFD 2017, 36): such a relative metric makes it challenging to assess decarbonisation efforts or real contributions to global warming due to the non-physical nature of the denominator, which can vary and thus alter the composite metric without any change in actual emissions. And such changes in actual emissions can be seen as relevant indicators for both transition risk vulnerability and systemic risk contributions. Yet, carbon intensity metrics are being widely used from financial index design (S&P Dow Jones Indices 2020) to accounting frameworks (PCAF 2020; TCFD 2021b) or so-called climate-alignment assessment methods (see SBTi 2021). The practical reason for the wider adoption of carbon intensity metrics is that they are relatively easy to compute and allow for a normalisation across companies or assets facilitating comparability. Quantitative comparability is also extremely useful within financial markets for scaling and automating assessment practices to e.g. screen portfolios or build financial products such as indices or ratings making carbon intensity scores an efficient tool to expand climate risk related product and service offerings.

In sum, there is a tension between offering an accurate (partial) representation of climate risk reality and being useful within an organisational status quo. Established market practice around climate risk metrics and models thus need to be interrogated. As the above paragraphs show existing sociological

theories and concepts are uniquely positioned to pose and address questions such as: What other organisational imperatives explain the adoption of specific metrics and models? What dynamics and institutions within organisational fields of finance inhibit or facilitate the wide adoption of metrics and models? Furthermore, organisational dynamics have also called for a growing development of indices, rankings, and scores. How are representations of reality contorted or fragmented in such processes of quantification and commensuration (Espeland and Sauder 2007; Sauder and Espeland 2009)?

5.3.3. Implementation

The construction of climate risk does not end with the dynamics surrounding design or adoption of a model; crucially, the ways in which organizations use models is equally critical. For that reason, in addressing this stage of action, our schema draws a conceptual boundary between decisions to adopt and to use. Sociological studies of how risk models are implemented into actual decision-making in organizations present a complex process, with multiple social and material constraints into the type of risk that is eventually considered, taken into account, and shapes action.

Key among these studies is MacKenzie's (2011) analysis of the practice of financial risk modelling and its implications for the 2008 global financial crisis. MacKenzie highlights the limited and problematic ways in which the implementation of financial models in siloed organizations can make traders miss key aspects of risk. Specifically, he considered the rating of derivatives of mortgage-based securities such as the famously toxic collateralized debt obligations, or CDOs, that brought down Wall Street banks. Such CDOs included a mortgage component and a derivatives component, and these were dealt with by two different units within credit rating agencies that had their own set of practices and assumptions. CDOs were modelled by the derivatives teams of rating agencies, which took as an input the original credit rating of the mortgage-based bonds leading to a systematic underestimation of the probability of default.

On a general level, this draws attention to the problem of organisational silos in model implementation. For instance, it inhibits integration across different valuation practices (MacKenzie 2011) in that they include tacit knowledge, specialized language, as well as unique tools, all of which conspire to make communication across modelling units costly and difficult. The organizational problems might be overcome, MacKenzie ventures, by avoiding the structural gaps among different units and departments. For instance, the derivatives trading floor described by Beunza and Stark (2004) included shared space and numerous mechanisms designed to promote social interaction across users of different financial models.

The analyses presented above point to the need to better understand organisational silos in the context of climate risk. In that regard, the work by Fiedler et al. (2021) is instructive as it highlights the

mismatch between information needs by business and finance to analyse climate risks and the actual information climate models can currently provide. While financially meaningful climate risk analysis requires information on near- and medium-term weather events with high spatial resolution to assess impacts on individual assets, multiple uncertainties inherent to climate models renders data outputs at this level of granularity highly unreliable. This, however, does not seem to keep companies and financial institutions from using such downscaled data and near-term climate futures as if they were as accurate as the precision of numerical outputs suggest (Fiedler et al. 2021). This poses questions for a sociology of climate risk on the organisational and cultural practices and institutions structuring the partiality of translating climate risk related models and their outputs. Which organisational arrangements and dynamics act as filter in this translation process? What are their functionalities? How does (the use of) the model (output) during implementation differ from its original form or intended purpose?

One of the solutions suggested by Fiedler et al. (2021) would be the creation of a new figure of “climate translators” (Fiedler et al., 2021, p. 92) needed to ensure proper use of climate science in climate risk assessments and to avoid e.g. overstating the precision and level of granularity of climate models. The issue is not merely solved by reforming the translation channels external to the company, i.e. having ‘climate translators’ mediating between e.g. the climate modelling community and specialised climate risk assessment units in a financial institution. Intra-organisational silos call for active translation as well. The issue of translating climate-related information across organisational boundaries also poses the question of the most suitable addressee for said information: Should certain climate-related information best be used at the level of the board or on the operational level, for instance? today.

With both growing sophistication of climate risk models and increasing expectations from supervisors and clients alike to implement climate risk assessments on the operational level, the avoidance of silos and thus the creation of model blackboxes becomes both more important and more complex. Assigning liaison officers or executives with responsibilities across organisational units to stem and facilitate the translation process of models and metrics alone becomes infeasible at a certain degree of climate risk assessment sophistication. Instead, models and organisational structures need to be fully integrated and have to co-evolve as climate risk assessment technologies change.

5.3.4. Performativity

Unintended consequences of the use of models and metrics do not exclusively originate from problematic arrangements within adopting organisations or from the biases built into said models. Once these models become widely used market devices additional dynamics can arise which become possible and significant due to the collective employment of the same models and metrics. In such cases, models no longer neutrally represent a (market) reality but actively shape this very reality

(MacKenzie 2004). In the words of MacKenzie (2006) they become “An Engine, Not a Camera” as their predictions instruct market actors’ behaviour. They become performative.

The case of the Black-Scholes-Merton option pricing model constitutes the perhaps purest form of what MacKenzie (2007) calls *performativity*: The originally often incorrect price predictions of the model shaped option traders’ pricing behaviour eventually leading to a convergence of prices towards the model predictions. Thus, the model brought about the very reality it set out to describe. While the previous sections discussed how models are shaped by organisational and other social dynamics, the performativity angle draws attention to how models in turn affect value (Braun 2016; MacKenzie 2007). As the case of Black-Scholes-Merton also illustrates, however, performativity does not simply arise from cognitive or linguistic dynamic but through academic authority legitimising the model as well as material arrangements such as the paper strips with option price tables facilitating the use of the model on the trading floor (MacKenzie 2007).

The widespread use of a model or metric can not only make its predictions more accurate as in the case of *performativity*, but it can also have the opposite effect: Models can become *counterperformative* if their predictions decrease their accuracy. An episode in the use of the Value at Risk (VaR) model illustrates this dynamic (Beunza 2019; MacKenzie 2005; Morris 2018): The use of VaR to measure market risk, originally developed and published by JP Morgan, gradually evolved into legitimate market practice and even became embedded into Bank for International Settlement regulation. The regulatory use of VaR thresholds and requirements in turn increased market volatility during the collapse of the hedge fund Long Term Capital Management and the associated market downturn. Hence, the systematic use of VaR as a model to manage and mitigate market risk paradoxically had a *counterperformative* effect in that it created additional market risk as other market actors were forced to sell off assets when the regulatory requirements around VaR thresholds could no longer be met otherwise (Morris 2018, 88–103).

A sociology of climate risk needs to investigate where *performative* effects might be in place due to the use of climate risk models. Performative moments, in which the distinctions between the economic phenomenon and the model representing it break down, cannot be captured by the positivist tradition of economics (whether orthodox or behavioural) whereas sociology is uniquely positioned to enhance understanding of said moments. A possible instance of performativity in the climate risk space are the climate stress tests conducted by central banks worldwide (NGFS 2021). By providing the financial sector with a range of financially more or less desirable scenarios, central banks create respectively more or less desirable investment pathways which – if followed by financial institutions – contribute to bringing about the respective future imagined in the first place. If so, what factors allow one scenario to become performative rather than another? The challenge of assessing such performative effects in

the context of climate risk modelling is that unlike Black-Scholes which entailed the modelling of a single variable, climate risk scenarios are produced by a (recursive) chain of over a hundred highly diverse models from e.g. global circulation to hydrological to econometric models which feed their results into the next model in the chain (see e.g. Lahsen 2005). How do performativity concepts from the social studies of finance need to be rethought in the context of these significantly more complex and diverse ‘model cascades’?

Sociologists of climate risk need to investigate the reverse of performativity – counterperformativity – as well. With capital markets increasingly considering climate risk factors in their sovereign risk assessments there is emerging evidence in economics of capital costs increasing for sovereign – and also corporate – borrowers exposed to modelled climate risk (Buhr et al. 2018; Volz et al. 2020). While climate risk could affect sovereign credit risk ratings across the board (Klusak et al. 2021), countries in the Global South tend to be more exposed to climate risk and hence more vulnerable to downgrading and rising capital costs according to these reports. To manage and prepare for said climate risks capital intensive adaptation measures are necessary. If climate risk induced capital cost spikes become prohibitive to the degree that needed climate adaptation measures cannot be implemented, the very model-based pricing of climate risk could spur the exacerbation of said risk. As the above illustrates the introduction of models into climate risk assessments creates unexpected feedback loops. Sociologists of climate risk should thus ask, under which circumstances does the use of climate risk models have counterperformative effects? What does such counterperformativity imply for the neoliberal model-based governance of climate risk that is currently prevailing (Christophers 2017)? How do market participants, regulators, and other affected actors address instances of counterperformativity?

5.4. An inclusive research agenda for the sociology of climate risk

As the paper has shown so far, models and their components are both a key force and a critical arena for the construction of climate risk. A sociology of climate risk needs to be wider, however, than the examination of climate risk models and assessments in the tradition of financial sociology. It cannot ignore, for instance, the intergovernmental climate negotiations structuring the context within which models are being designed, selected, and deployed. Thus, an integrative sociology of climate risk needs to encompass the institutional arrangements legitimising the use of models. Going further, a sociology of climate risk also needs to consider how climate risk perpetuates, solidifies or possibly challenges existing asymmetric relationships between the Global North and the Global South as, for instance, visible in global debt structuring via e.g. the IMF. Hence, it must address how climate risk reconstitutes identities and relations of the human as well as the non-human world. Lastly, whether it is Fridays for

Future, Extinction Rebellion, or climate scientists, a sociology of climate risk should investigate alternative frames and framing attempts and the limitations of the climate risk frame.

How can these research foci – institutions, identities, and frames – as well as the suggested starting point of a sociology of climate risk – models – be placed into a coherent framework? We propose the concept of economization for that purpose. Economization is defined as “the processes through which activities, behaviours and spheres or fields are established as being economic (whether or not there is consensus about the content of such qualifications)” (Çalışkan and Callon 2009, 370). In the context of climate risk, we conceptualise this process of fitting climate change into a cognitive frame compatible with market economic rationalities as economization (Elliott 2021). In other words, economization allows us to theorize the laborious and non-linear process of making the phenomenon of climate change legible to financial market actors.

Approaching climate risk through the lens of economization is instructive in that it centres an understanding of climate risk around the role of calculative practices in framing climate risk. It thus focuses attention on *both* the numerical constitution of identity and relations within the climate risk frame (i.e. what lies inside the frame); and on the inevitable overflows of dimensions and relations staying outside of the frame (Callon 1998). Hence, it enables an investigation of the current construction of climate risk taking both the ‘inside’ of models and their results seriously while maintaining a sensitivity for their inevitable limitations. As the work of Elliott (2021) exemplifies, the use of flood maps presented the threat posed by floods in New York City’s coastal communities in economic terms while rendering invisible the dangers to family stability, community ties, and cultural lifestyles. In other words, the introduction of a new calculative frame, the flood maps, captured certain economic risks that had previously been excluded while leaving others neglected outside the frame.

A second advantage of an economization lens is that it relates models and tools to the political contestations of alternative frames in processes of problematization. In other words, there is a strong political dimension to the construction of climate risk which permeates both the outside and the inside of calculative practice. In the case of the tool considered by Elliott (2021), flood maps formed the basis for a radical repricing of flood insurance premia. This repricing immediately impacted coastal residents’ ability to continue with their living arrangements, becoming actively contested and the site of political resistance and controversy. The threat posed by economization led to a movement seeking to stop and reverse it and was ultimately echoed in the City Council’s decision to abandon the use of the disputed flood maps. Thus, one cannot understand the resistance to FEMA and the City Council without understanding the calculative tools underlying the economization of flood risk in New York City.

Economization, in short, illuminates the dual role of calculation and political contestation. Now how can this conceptual frame help in formulating an integrative sociology of climate risk? In other words, how can economization tie together models, institutions, identities, and frames? Answering this question, we suggest following the economization process in three directions.

First, following economization requires a widening of focus to stages prior to model and framework design; in other words, moving ‘upstream’ the process of economization. This implies an investigation of the institutions creating the conditions in which modelling climate risk becomes a legitimate exercise in the first place. Fligstein (1996), for instance, has established how new markets arise from meso-level institutional orders or fields in which stability arises from attempts at mitigating competition. This order is partly created by modern states, and partly arises from power struggles across firms. By moving upstream, a sociology of climate risk can connect concepts like performativity and calculative practices with a rich literature in the sociology of markets to account for the institutional dimensions of constructing climate risk. Indeed, sociology of markets research has demonstrated that financial risk cannot be understood without reference to state politics. In that vein, Quinn (2019) has shown how the American government has created financial credit programmes such as Ginnie Mae and Freddie Mac to redistribute mortgage risk promoting home ownership. Similarly, Krippner (2011) has documented the political origins of the unleashing of private risk-taking opportunities in the 1970s central to the recent rise of the financial sector in the US.

In line with the above, a thorough understanding of climate risk needs to engage with the political dynamics of how climate is economized, as well as how that economization is contested. Indeed, the emergence of the central institution in the development of climate risk, the TCFD, did not only timing-wise coincide with the COP21 in Paris but was also to a large extent diplomatically facilitated by the French COP21 team securing a G20 mandate. In other words, economization cannot be understood without accounting for the role of international and intergovernmental institutions. How do such institutions like the Financial Stability Board (FSB), the IMF or the Bank for International Settlement (BIS) guide the transformation of climate change into climate risk? How do the ideas of orthodox economics and the ideals of neoliberal governance baked into the design and identity of the Bretton Woods institutions structure how they understand and grapple with climate change? How do other international organisations such as standard setters like the International Organization of Securities Commissions (IOSCO) or the International Accounting Standards Board (IASB) relate to such intergovernmental work?

Domestic politics and institutions play a role in the construction of climate risk as well. For instance, the creation of another international organisation central to the construction of climate risk, the NGFS, seems tightly linked to domestic US politics. With the election of Donald Trump as president, climate

change became a taboo issue for the US making productive work and progress on climate within the G20 impossible.¹¹ The founding of the NGFS as ‘coalition of the willing’¹² in 2017 was a direct French-led reaction to domestic US actors. Thus, a sociology of climate risk needs to understand how domestic state institutions structure, demand or oppose moves to economize climate change. For instance, how do state actors use international organisations and fora to slow down, accelerate, or otherwise shape engagement with climate risk on the international stage?

Second, a sociology of climate risk must not stop where the concepts of *performativity* or *counterperformativity* break down, for it could neglect whose interests and values are thus cemented or marginalised. Instead, it must trace how the effects of climate risk modelling and assessment keep rendering entities and relations economic ‘downstream’ in the economization process. Elliott (2021), for instance, contrasts the unidimensional conception of loss and risk created through flood insurance with the multi-dimensional reality of loss and risk perception of (potential) flood victims in New York City, demonstrating how economization through the technology of flood maps can create new types of risks and losses for those being governed by it.

How can such rendering economic be identified and navigated? How are identities and relations being redefined and reconfigured? What are the effects of these redefinitions and how are they resisted or adapted to? Here, development sociology can shed light on this downstream stage of economization by providing conceptual toolkits and examples of the type of relations that are being created and lost when constructing imaginaries of climate futures (see e.g. Beckert 2016; Jasanoff and Kim 2015). For instance, the concept of anticipatory ruination developed by Paprocki (2019) describes how anticipatory risk governance can lead to a pre-emptive process of inflicting damage reinforcing colonial patterns and relations. This approach can help to extend and supplement the performativity concept by examining how the imagination of catastrophic climate futures might effectively reinforce post-colonial tensions. Another example is the concept of rendering technical developed by Li (2007). This concept underscores the need to investigate the role of climate risk models in rendering political questions technical thus affording specific actors with expert status a position of authority allowing them to make decisions on political questions without leaving the domain of their technical responsibility. The effects of economization through climate risk on non-human, i.e. environmental, relationships and identities can become better understood through environmental sociology and its treatments of relevant natural sciences such as ecology and biology (see e.g. Porcelli and Besek 2021).

¹¹ See e.g. <https://www.responsible-investor.com/china-and-the-us-to-lead-rebranded-g20-sustainable-finance-study-group/> on the renaming, abandoning, and relaunching of the G20 Green Finance Study Group.

¹² <https://www.ngfs.net/en>

Environmental sociology can thus sharpen the analytical lens for how natural phenomena are being affected and assigned new roles in a network of human-nature relations.

Third, the concept of economization requires the extension of a sociology of climate risk along a third direction, namely alternatives to economization. Conceptualising climate risk construction as economization necessarily poses the question of what alternative problematisations are being attempted or prevented. After all, economization is just one particular instance of problematization (Callon 2009) – i.e. re-defining an issue by foregrounding some of its characteristics thus justifying the prioritisation of certain ways of relating to the issue. For instance, natural science framings of planetary boundaries (see e.g. Steffen et al. 2015), the conception of climate change as a national and regional security issue (Lucke, Wellmann, and Diez 2014) or the understanding of climate change as climate emergency promoted by social movements such as Fridays for Future or Extinction Rebellion (see e.g. McHugh, Lemos, and Morrison 2021) entail a characterisations of and implications for how to act on climate change radically different from climate risk. Thus, the concept of economization asks for extending the scope of a sociology of climate risk *sideways* to capture problematization attempts outside of the mainstream of economization.

The advantage of considering alternative problematisations in relation to economization (as opposed to in their own right) are multiple. First, by shedding light on particular limits of the existing approaches to climate risk, it explains situations in which this economization frame is adapted. An instance of adaptation might be given by Chenet, Ryan-Collins, and van Lerven (2021) who proposed an alternative problematisation of climate futures as a case of radical uncertainty rather than calculable risk (see also Bolton et al. 2020), warranting a financial system response based on the precautionary principle. Such an approach could, for instance, call for the abandonment of the ‘polluter pays principle’ enshrined in ideas of carbon pricing and instead establish the ‘polluter proves principle’ demanding economic activity to prove climate neutrality. In other words, by challenging the underlying assumptions of the neoliberal economization frame, Chenet and colleagues open up cognitive space to propose calculative alternatives to governing climate change. This presents opportunities for sociologists of climate risk to ask questions like which of such approaches can be incorporated into the economization frame? Under which conditions do attempts to adapt the economization frame succeed or fail?

Second, an analytical ‘sideways’ movement can help identify and explain moments in which the economization frame is abandoned. As example of abandoned economization, i.e. downstream problematization, Elliott (2021) shows how residents contest the deployment of climate risk tools in the form of flood maps and insurance premia eventually leading to their rejection by the New York City Council. This case points to the conditions in which the climate risk frame breaks down. For instance, the novelty and fragility of the device representing climate risk – the flood maps – made criticism and

contestation easier. Also, decision-making responsibility lied with elected officials rather than appointed specialists. Thus, a sociology of climate risk should address related questions: For instance, how do distributional options available to decision-makers mediate the survival of the economization frame? Furthermore, what are the effects of abandoning the climate risk frame when climate threats have not disappeared?

Third, moving ‘sideways’ brings into focus non-economizing problematization frames which are ignored or silenced within the economization frame. They make-up a category of alternative problematizations distinct from those that are in an openly articulated dispute with the climate risk frame as discussed in the previous paragraphs. An example of such a marginalized frame is the idea of treating climate change as an emergency (see e.g. McHugh, Lemos, and Morrison 2021) legitimating extraordinary measures by financial actors. Examples include e.g. credit guidance actively supporting climate-friendly economic practice, ‘green’ quantitative easing, or trading bans for fossil fuel related financial products (see e.g. Dikau, Robins, and Volz 2020). Exploring such ignored and silenced frames could not only shed light on otherwise difficult to capture power asymmetries surrounding climate risk. How, for instance, does the climate risk frame shut down cognitive or material pathways towards alternative problematizations? Under what circumstances do marginalized frames become viable?

5.5. Conclusion

Recent years have witnessed a concerted regulatory effort to introduce climate change into the economic calculations of investors and corporate managers. The effort, which is summed up by the expression ‘climate risk’, has primarily taken the form of new reporting requirements for large corporations, as well as new supervisory practices by central banks. An emerging scholarly literature has cast doubt on the effectiveness of this coordinated market intervention, pointing to the calculative, supervisory, and political shortcomings of such neoliberal and technocratic project.

This study aims at empirically organizing and conceptually integrating the nascent literature on this new phenomenon of climate risk. In doing so, we call for a broader sociological engagement with climate risk, outlining how economization can integrate an institutional and a material approach to climate risk. It considers, first, the complex institutional work that went into making climate change readable to financial actors, culminating in two key institutions, the TCFD and NGFS, that picked up starting in 2015 the leading role played by the UN and related investor networks during the 1990s and 2000s. Our study turns to the models informing e.g. climate stress testing and the TCFD reporting frameworks – the tools and texts that make climate risk legible to financiers – and draws on the social studies of finance to highlight possible modelling pitfalls and counterperformative threats. Finally, we lay out how Callonian economization can integrate these perspectives, identifying areas of research on the institutional antecedences of model design, the effects of large-scale model deployment, and

alternative problematizations of climate change. Our study illustrates the need to mobilize the full spectrum of sociological expertise – from development to political and economic sociology – to understand and critique the reality of climate risk.

Admittedly, our study neglects a related socio-technical process, namely, the civilizing effect exerted by climate risk regulation on markets. By "civilizing markets", Callon (2009) means the process whereby market design gives voice to multiple concerned actors, taking into account the issues and matters of concern that arise from the operation of the market. Such repoliticization of the market may operate as counterpart to the economization of climate change that our study considers. In effect, the concept of civilizing makes clear that an expansion of the scope of the market entails a two-way transformation. On the one hand, integrating climate change into economic decision-making reduces a multi-faceted issue to smaller, more actionable, network of problems around financial stability. On the other, the institutions contributing to the construction of climate risk, from the climate change conferences (UNFCCC COPs) to the IPCC and the European Commission have the potential to give voice to "orphan groups" that have traditionally been considered fringe in bank supervision or corporate reporting debates. The extent to which the climate risk agenda serves as mere reproduction of financial capitalism or the colonization of finance by activist groups is yet to be established, and much depends on the interplay between the economizing and civilizing effects of the climate risk agenda.

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6. Discussion

What is it, that this set of papers can tell us about the finance-climate nexus? What is the essence, the contribution of this thesis? While this final chapter attempts to answer this question, it does so with an ANT-inspired caveat. This discussion focuses on the connective tissue of this PhD, i.e. the themes running through multiple papers, and on what, as a ‘whole’ this thesis contributes to our understanding of the finance-climate nexus. It is therefore not a comprehensive summary of findings and contributions as “the whole is always smaller than its parts” (Latour et al. 2012, 590), but it adds to and connects them.

The next section characterises the climate risk translation processes as covered in this PhD as a whole, drawing out some existing and potential tensions which can help to guide attention where academic problematization and/or policy action is needed. The following two sections spell out a series of key contributions this PhD makes to the literature on the finance-climate nexus and to ANT. Lastly, it formulates implications both for future academic research and for policymakers.

6.1. Translating climate risk: an actor-network under tension

This PhD has traced the construction of climate risk understood as translation through the vignettes of the TCFD and the NGFS reference scenarios. It is of course limited by its case study design only capturing one strand of a swirl of institutions and ideas contributing to the construction of climate risk. This strand of the translation process covered is characterized by a set of paradoxical or contradictory moves creating an actor-network under tension. These tensions might well occur in other areas of the climate risk construction space and could therefore be instructive in understanding climate risk translation beyond the TCFD and the NGFS.

Most obviously, climate risk as knowledge object has become more or better defined. The TCFD disclosure framework demarcates climate risk along organisational boundaries, specifies different types of risk, and spells out industry-specific ways to assess these risks. Mathematical models such as those underpinning the NGFS scenarios have introduced the precision of numbers into the ways we can know climate risk. At the same time, however, climate risk has become less defined. At the beginning, climate risk was understood to materialise via one single pathway in one single sector. Climate risk was originally constructed as pertaining to the fossil fuel sector and was premised on the assumption that humanity would indeed reign in its collective GHG emissions to maintain a liveable planet. This singular conception of climate risk has by now multiplied into legions of climate risk transmission channels and levels of risk intensities with unlimited permutations. While – within the logics of the original climate risk frame – climate risk could be clearly defined as ‘high’ and ‘relevant’ for a company like Shell, materialising through climate policies, an increasing granularity of the

definition of climate risk conceptually now makes it significantly more difficult to define climate risk concretely. Thus, the translation of climate risk has simultaneously led to a more *and* less defined understanding of climate risk.

This advances debates on sociological approaches to risk and debates on how futures are being brought into the present. It nuances the common argument that risk and present futures fulfil the function of coordinating actors and facilitating collective action (Beckert 2016; Beckert and Bronk 2018; Doganova 2021; Jasanoff and Kim 2015). While climate risk getting more defined indeed allowed for increasing coordination and collective action of e.g. central banks in the NGFS or industry representatives within the TCFD, climate risk getting less defined appears to stall and inhibit coordination and collective action on other fronts. For instance, adjustments to capital requirements, collateral frameworks, or risk premia, i.e. key instruments of coordination in financial markets, are still not in sight some seven years after Carney's speech on the tragedy of the horizon. Less defined climate risk inhibiting collective actions might also help to explain the mushrooming of initiatives focused on the facilitation of collective action around 'climate alignment' or 'net zero targets' such as the Climate Action 100+ coalition or the Glasgow Financial Alliance for Net Zero (GFANZ). This PhD does not argue that climate risk or imagined climate risk futures *per se* are inappropriate devices to facilitate coordination and collective action (unlike e.g. Ameli et al. 2020; Ameli, Kothari, and Grubb 2021; Christophers 2017). It rather suggests that the imagination of climate risk futures has contradictory effects fulfilling the function of coordination on some levels while failing it on others.

In another paradoxical move, translation has rendered the construction of climate risk both less and more localised. On the one hand, climate risk construction is no longer quarantined to small groups of technocratic or financial elites in London and Paris. It has spread to board rooms, the risk function of banks, NGO offices, and the macroeconomic departments of central banks still with a concentration in the Global North but a rapidly growing involvement of especially Asian localities such as the People's Bank of China. Simultaneously, the forward-looking mathematisation of climate risk construction implies a countermove that contracts rather than expands. As the third paper notes, the design and administration of models needed as fundamental operating systems and input generators for quantitative climate risk assessment is highly concentrated in few localities which in addition are closely connected and actively pursue a certain degree of homogeneity through model intercomparison projects – sometimes in problematic ways (Cointe, Cassen, and Nadaï 2019; Low and Schäfer 2020, 5; Sundberg 2011; Touzé-Peiffer, Barberousse, and Le Treut 2020). Understanding climate risk construction as translation, i.e. employing an ANT lens, helps in understanding this state not as the discovery of a global essence of climate risk – or climate change for that matter – but the successful translation of local perspectives on climate risk. Thus, the construction of climate risk has

simultaneously become more and less localised. This extends the geographic literature on climate models and climate science, how they travel, and how they contribute to the construction of a global gaze on climate (Heymann, Gramelsberger, and Mahony 2017; Mahony and Hulme 2012; 2018) into the sphere of finance where it challenges an often naturalised view of global climate (risk) models (Allen et al. 2021; D’Orazio and Popoyan 2019; Diaz and Moore 2017; Rising et al. 2022; Svartzman et al. 2020).

Lastly, the climate risk as knowledge object has become both more and less controversial. The existence and relevance of climate risk as such has become nearly unambiguously consensual within finance. While even the Governor of the FSB had to face criticism for suggesting that climate risk was not sufficiently accounted for within financial markets in 2015 (Giugliano 2015), such criticism – i.e. stating that climate risk is negligible for finance – recently got the global head of sustainable investing at HSBC’s asset management arm suspended (Agnew, Mundy, and Morris 2022). Simultaneously, climate risk has become infinitely more controversial as a knowledge object. The exact measurement and magnitude of climate risk, the choice of metrics and indicators, and the robustness of climate risk assessments sufficing their integration into regulatory and supervisory frameworks are all subject to fierce debate now. Controversies around climate risk have not only widened thematically but also in terms of who is involved. Debates between individuals at dinner parties in London have now expanded to controversies between climate modellers and central bankers. Thus, climate risk has become both more and less controversial.

Of course, these contradictory moves in the climate risk translation process or not as directly contradictory and thus not as paradoxical as simplistically suggested. Climate risk is more defined on a conceptual level and less defined on a practical level; it is less localised in its later stage construction on more localised in its early-stage construction; it is less controversial as a concept but more controversial as a concrete quantity. Thus, these movements do not directly oppose each other but pertain to different layers of the same dimension of what climate risk as knowledge object is. Like tectonic plates, these layers can create frictions and can detach when moving into opposite directions. So far this has mostly caught the attention of academics where such frictions and detachments pertain to ‘global’ climate-related models becoming detached from their local application (Fiedler et al. 2021). Where, whether, and how such frictions and detachments triggered by the movements outlined above occur and with what effects is the task for future research. The fourth paper in this PhD provides the first draft of a map for such research endeavours charting and tracing a climate risk actor-network under tension.

6.2. Contributions

If the fourth paper provides the first sketch of a map to navigate climate risk as a research object, the other papers have both populated the map with empirical detail and generated lessons on what areas of the map might be worth prioritising and how to travel the territory. The following two sub-sections expand on this PhD's contributions to these questions of 'what' – contributions to the literature on the finance-climate nexus – and the 'how' – contributions to ANT.

6.2.1. To the literature on the finance-climate nexus

6.2.1.1. *Centring the role of risk*

This PhD is not the first piece of research concerned with the role of risk in the organising of the finance-climate nexus. Previous research has highlighted the insufficient or silencing effects of calculative devices in investment (Christophers 2019) and insurance practice (Elliott 2021). It has drawn attention to how risk is a matter of concern for central banks increasingly becoming active in the finance-climate nexus (Langley and Morris 2020) and how it can serve as discursive political instrument to perpetuate a status quo for industry incumbents (Nyberg and Wright 2016). What this PhD adds to the emerging literature on climate risk is that first, it conceptually centres and hence clarifies the fundamental role of risk in how finance relates to the planet's climate. Second, it empirically unpacks the politics of its construction rather than exclusively focusing on the politics of its deployment partially naturalising and reifying climate risk as, for example, Christophers (2019) does. While the latter is foregrounded in all empirical papers of this thesis and thus does not need summarising, the former is more of an undercurrent and thus requires a more explicit discussion.

While the financial crisis of 2008 might have shifted the focus from risk taking to risk control (Palermo, Power, and Ashby 2017), risk remains as heuristic frame and as governance object at the heart of finance (Goede 2004; Green 2000; Power 2007; Zaloom 2004). Thus, as this PhD shows, climate risk is conceptually different from carbon markets, climate-related insurance, the commodification and assetization of nature, and the markets for so-called green financial products. The respective literatures on these latter phenomena see them as located at the frontier of an expanding financial system, i.e. the frontier of financialization where finance colonises nature (Bracking 2012; Levidow 2020; Lohmann 2012; Ouma, Johnson, and Bigger 2018). For instance, Knox-Hayes (2010) and Lohmann (2009) show how carbon is transformed and reconfigured in order to become a tradable commodity without noting any effects that carbon – now integrated into financial markets – might have on finance. These literatures thus focus on what is specific about the time we live in – the Anthropocene –, namely the shaping of nature by humans. They analytically foreground the effect of finance on nature or the nature-society nexus thus exploring the frontiers rather than the heartland of finance.

This PhD on the other hand, by centring (climate) risk, focuses on finance's core to analytically balance the relationship between humans – or more precisely finance – and the planet's climate. It thus complements and advances the literatures on the finance-climate nexus: Climate risk entails the reciprocal relationship between finance and climate, the mutual colonisation of these two spaces. In the first paper, climate enters the sphere of global financial supervision and central banking while being transformed into two categories of risk – physical and transition risk. Thus, by centring climate risk, central banks can be understood as not simply choosing to become "climate governors" (Langley and Morris 2020) but as being drawn into the issue field of climate change due to the successful translation of climate risk. The second paper shows how board rooms, accountants, and risk managers are brought to let the issue of climate into their life worlds by adapting it according to the compromises between interests clashing within the TCFD. Thus, the TCFD becomes not simply an instance of financial markets governing climate change in the most neoliberal and thus convenient way possible (Christophers 2017). Centring climate risk makes the TCFD visible as a project to bring the issue of climate change into the sphere of (corporate) finance as priority to adapt to, as the contested and constructed concept of climate risk mediates this translation. As illustrated in the third paper, climate is now also entering the mathematised spaces of stress testing after being moulded by a set of reputational, technical, professional, and operational imperatives. Instead of raising questions on problematic aspects of traditional financial stress testing in this context (Langley and Morris 2020), centring climate risk prompts an inquiry of its contingent construction unveiling how the specificities of climate scenario design – e.g. involving IAMs and climate scientists – and not just engrained central banking practice render them problematic. Thus, centring climate risk makes visible effects of climate change transforming central banking practice – e.g. the delegation of tasks to climate scientists – as much as it helps to show how climate futures are shaped by finance and e.g. its operational imperatives. Where finance seems to be unaffected by climate change as in the case of investment practice described by Christophers (2019), the climate scenario paper also demonstrates how centring climate risk and its calculative construction can provide rich diagnoses of the relevant underlying pathologies leading to e.g. an exclusion of extreme stress scenarios and thus potentially an underestimation of climate risk.

Together, these governance institutions of which central banks are one of the most pivotal, the organisational functions addressed by the TCFD recommendations, and calculative devices bringing the future into the present such as climate scenarios, make up the infrastructure of finance. This PhD shows how this infrastructure is both reconfigured by and reconfiguring climate change. With the balancing of risk and return lying at the heart of finance, centring risk when researching the finance-climate nexus means to move the spotlight from where the issue of climate change is quarantined at the edges of expanding finance into its engine room.

The conceptual stance of understanding climate risk as moving climate change into the ‘operating system’ of finance – supervision and regulation, calculative practices and devices, the cognitive engine of balancing risk and return – does not imply a normative stance or a promise. Whether this translation of climate change will or can result in changes of capital allocation supporting climate change adaptation and mitigation at the pace and scale needed is an open question. In fact, this PhD gives rise to a series of doubts whether the current (calculative) practices, governance fora, and legal environments this translation is moving through can affect such changes. In that regard, it adds additional layers to concerns articulated in the wider literature around the theoretical and practical shortcomings of climate risk disclosure (Ameli et al. 2020; Ameli, Kothari, and Grubb 2021; Bingler et al. 2022; Christophers 2017) and the inadequate nature of climate risk related calculative devices (Christophers 2019; Fiedler et al. 2021). It does so by unpacking how social and organisational fixtures and dynamics shape the frameworks and models underlying disclosure and calculation rather than focusing on their use.

6.2.1.2. *(Dis-)embedding the cognitive layers of the finance-climate nexus*

As highlighted in the introduction of this thesis, engagement with the cognitive dimension of the finance-climate nexus is rare. By centring the cognitive frame of climate risk, this PhD starts an explicit dissection of the cognitive layers of the finance-climate nexus and thus develops what in the fourth paper of this thesis is called the sideways movement of identifying, contrasting, or relating alternative frames. It thus advances a literature on the finance-climate nexus that broadly falls into two camps. On the one hand, studies that do not explicitly identify cognition as relevant sphere of world-making and social ordering tend to understand the development of the finance-climate nexus as an interplay of interests, state institutions, and organisational work conflating different frames in that process (e.g. Beunza and Ferraro 2018; Giamporcaro and Gond 2016; Gunningham 2020; Lewis and Juravle 2010). For instance, the frames of sustainability and risk are become confused and entangled in accounts of the rise of socially responsible investing (Arjaliès 2010; Durbin and Welch 2002; Sakuma and Louche 2008). This PhD challenges and significantly advances the literature in this camp as it demonstrates how cognitive frames are shaped by but also mediate the realization of interests making it pivotal to both integrated them into analyses and differentiate between them.

On the other hand, a second camp acknowledging the relevance and heterogeneity of cognitive frames tends to treat them as static and either fundamentally opposed (Nyberg and Wright 2016; Revelli 2017; Richardson and Cragg 2010) or as simply co-existing (Dimmelmeier 2021). In a nutshell, this PhD shows how climate risk is both separate(d) from and embedded in alternative frames thus nuancing this literature. Cognitive frames dynamically compete, overlap, and displace one another in the negotiations and constructions of governance frameworks and tools. The first paper in this thesis

demonstrates how the risk frame in fact relied in its emergence on actors such as entrepreneurial NGO representatives and the French COP21 team driven by frames of the planet's climate highlighting climate stability and climate alignment. The same paper highlights not just such a relationship of dependence but also of friction where the singular narrative of a future with ambitious and effective climate policies needs to be supplement by a future without climate action, creating distance between the risk frame and an original climate stability frame. The second paper provides more examples of such friction and increasing distance such as the rejection of climate lobbying disclosure while also pointing to moments of overlap where the consideration of a 2°C scenario is specified as TCFD recommendation. While the third paper primarily highlights the purification of mathematised climate futures from sustainability or alignment frames, the existence of net-zero scenarios still demonstrates a not completed dis-embedding of climate risk from alternative frames.

Such detailed work – whether empirically as in this PhD or conceptually – of both dis-embedding the risk frame, i.e. showing how and where it is disconnected from alternatives frames, and embedding, i.e. identifying and drawing links to other frames, can be a first step towards “civilizing markets” (Callon 2009). Making explicit multiple contrasting problematisations of climate change within finance can allow to understand the current relation between finance and the planet's climate not just as “tragedy of the horizon” (Carney 2015) but rather as a friction between singular and multiple conceptions of value (Carney 2021). Relating them and pointing out overlaps or points of contact could prepare the ground for productive dialogue rather than fundamental opposition. Instead of waiting for the inevitable misfires and overflows of any cognitive frame (Callon 1999; 2010) to escalate controversies thus inviting a contrasting and relating of frames, this thesis demonstrates that such research work can already be done during the phase of frame construction. This front-loading of such analysis is particularly critical in the context of climate risk where time is of the essence and an ex-post assessment might be of exclusively intellectual value.

6.2.1.3. *Present future tensions*

Given the nature of risk as referring to events in the future, it is not surprising that many contestations traced in this PhD revolve around visions of the future. This charters new territory in the finance-climate nexus literature. While multiple studies have generated deep insights into contestations of the present, e.g. contestations of ‘sustainable’ or ‘green’ financial product standards and ratings (Arjaliès and Durand 2019; Giamporcaro and Gond 2016; Slager, Gond, and Moon 2012), they do not explore how these contestations either rely on or construct certain vision of the future despite the fact that ideas of ‘greenness’ or ‘sustainability’ necessarily imply such visions. Even studies explicitly identifying imagined futures as key component of contestation, e.g. in the context of flood insurance disputes (Elliott 2021) or the calculation of avoided GHG emissions (Knox-Hayes 2010; Lohmann 2009) and GHG

effects (Skodvin 2012), contestations are conceptualised as fully pertaining to and being located in the present. This PhD highlights the contestation of futures and the tensions between different version of present futures, i.e. versions of futures brought into the present. What connects these tensions is a reoccurring opposition of singularity and multiplicity as well as of empowering certainty and paralysing uncertainty coming with these singularities and multiplicities respectively. It therefore enriches the literature on roadblocks to aligning capitalist financial markets with climate goals by not focusing on market mechanisms and features as barriers (Ameli et al. 2020; Ameli, Kothari, and Grubb 2021; Christophers 2017; Svartzman and Althouse 2020) – while without doubt significant – but by addressing how capitalist economies rely on infinite and open, i.e. multiple, futures (Beckert 2016) that always hold the promise of progress and greater wealth for everyone (Beckert 2019) foreclosing singular futures that could facilitate collective action.

Starting in the first paper, the resolve of proponents of the early climate risk claim, i.e. the claim that there is a carbon bubble, was tightly connected with this singular depiction of the future. Carbon has to remain in the soil for humanity to survive, hence investment in “unburnable carbon” (Carbon Tracker Initiative 2011) is a bad investment and needs to stop. This certainty and its prescriptive implications had to be abandoned in the face of doubt over the political will to shut down a profitable industry. Climate risk thus multiplied into physical and transition risk and the future thus became multiple, too. This complicated instructions for how to act on climate risk debilitating divestment proponents but maintaining flexibility and autonomy of carbon investors. More information was needed now to understand climate risk. In the second paper, some actors with a clear vision on how to act attempted to introduce their singular vision of the future, a future aligned with the Paris Agreement, into the TCFD recommendations. The prescriptiveness of such a singular future, however, was seen to constrain the flexibility of heterogeneous corporate market participants. Hence, the future remained multiple so ‘the market’ as a whole could remain divergent in action. In the third paper, this multiple future was no longer questioned but rather reduced and concretised. It is still instructive in terms of understanding the absence of a singular future as it suggests a mismatch between the institutions legitimating knowledge about the future and the capacity to imagine catastrophic futures – whether financially, environmentally, or otherwise catastrophic (see also Sklair 2020; Spratt and Dunlop 2018). Such catastrophic futures – when accepted as reasonable and plausible – could focus collective attention. Unlike the singular future at the beginning of the climate risk translation process, such a more explicitly negative singular future might be less directly instructive but nevertheless define a shared desirable future *ex negativo* and thus facilitate collective action.

Thus, reading the translation of climate risk as an (unintended) facilitation of inaction due to the avoidance of singular futures has two broad implications. Empirically, it emphasizes the need to

academically trace and interrogate how futures are imagined in the present to understand how singular futures can emerge or how action can still take shape in the face of multiple futures. Thus, the practice of strategy management and its engagement with time and futures needs to come into focus in this context as proposed by e.g. Doganova and Kornberger (2021). Conceptually – but also from a policy-oriented perspective – it invites to shift attention to sites outside of specialist and scientific knowledge production to produce singular futures. As Beck (1998, 14) puts it passionately: “[P]olitics and morality are gaining – have to gain! – priority over shifting scientific reasoning” where such “shifting scientific reasoning” is insufficient to provide unambiguous certainty – as in the context of climate change.

6.2.1.4. Central bankers as creative and heterogeneous governors of the finance-climate nexus

A final common thread throughout this PhD is the pivotal role of central bankers. The thesis thus contributes to and connects the literature on financial governance where central bankers have been identified but not yet thoroughly examined as “climate governors” (Langley and Morris 2020) and the literature on environmental governance where some attention has been paid to the role of investors (MacLeod and Park 2011) and finance ministries (Skovgaard 2012) but not central banks. The knowledge-focused perspective of this thesis enriches these literature by unpacking how central banks fulfil the governance function of problem definition – a function often neglected in the environmental governance literature where problem definitions and the knowledge underpinning them are often taken for granted (Allan 2017; Barry 2012; Williams 2012). The thesis also connects with and advances the environmental governance literature by investigating the construction of climate scenarios as governance tool often highlighted as critical for its performative and coordinating functions but rarely examined in depth (Garb, Pulver, and VanDeveer 2008; O'Neill et al. 2008; Pulver and VanDeveer 2009; VanDeveer and Pulver 2021). Hence, this PhD lays the groundwork for a deeper understanding of the mode and nature of central banks governing the finance-climate nexus.

In all papers, central banks appear as creative and heterogeneous governors. They prove creative in organising their various governance efforts. The TCFD as instance of orchestrations (Abbott and Genschel 2015) created a miniature public within which questions of disclosure and accounting could be exposed to the politics of competing knowledge claims around what climate risk is and should be (see also Thistletonwaite 2015). While the outsourcing of such a governance task was not completely unprecedented, it was still experimental not simply indicating a need to outsource – e.g. to avoid FSB-internal veto players – but also an intrinsic willingness to delegate a governance task thus somewhat challenging functionalist explanations of delegating authority (Bulkeley et al. 2014, 42–45; Green 2014). The workings of the NGFS in the third paper of this thesis showcase even more openness of

central bankers to experiment with novel ways of organising around governance tasks. The NGFS itself has a flexible network structure open to central banks and financial supervisors regardless of their financial clout – unlike e.g. the FSB. Its willingness to engage with and delegate responsibilities to external actors such as foundations and climate research centres to generate knowledge outside of the Bank for International Settlement (BIS) system is a novelty. These findings point to the opportunity of connecting literature on governance experiments in environmental governance (Bulkeley et al. 2012; Hoffmann 2012; Kivimaa et al. 2017; Laakso, Berg, and Annala 2017; Matschoss and Repo 2018) with literature on the finance-climate nexus and central banking to better understand how and why such governance experiments might fail or succeed. This PhD – while not directly addressing questions traditionally at the heart of the governance literature – provides some first insights into, for instance, the basis of central banks' authority in this space drawing on both their state-backed legal mandate they carefully guard through boundary work and on the legitimacy of allies they enrol such as climate scientists.

Central bankers have not just shown to be creative but also heterogeneous actors further emphasizing the need to understand not just financial markets but also financial regulation and supervision as inherently social and not purely economic endeavour (Black 2013). Such heterogeneity manifests on the organisational level in the form of involvement in governing the finance-climate nexus as the first and second paper has shown highlighting the central role of the Bank of England. Similarly, the degree of engagement with the design of the NGFS scenarios in the third paper differs significantly among NGFS members. This PhD offers some explanations for this heterogeneity on the organisational level: The embeddedness of central banks into both a domestic environment of elite networks and politics mobilising e.g. the Bank of England, and an international environment of G20 and UNFCCC politics with their respective opportunity and expectation structures plays a key role in shaping central banks' positions. Perhaps trivial but not to be neglected is the factor of capacity and resourcing. The absence of central bank staff from the Global South in the NGFS scenario design process can hardly be explained with a disregard of climate change or climate risk in the respective organisations but rather with a lack of resources to spare staff. Such resource asymmetries between central banks go beyond mere staff numbers and extend to the global monetary hierarchy affording central banks with widely different powers to affect global capital flows and eventually environmental outcomes (see Svartzman and Althouse 2020). As hinted at several times in the third paper of this PhD, it is not just central banks that differ but also central bankers. While a certain homogenization of views through interaction in transnational networks among central bankers is taking place (Marcussen 2006), it seems that on matters of climate central bankers are still not a closed epistemic community (see also Kapstein 1992). By unveiling these different dimensions of the heterogeneity of central banks and central bankers as governors this PhD nuances a nascent literature that has so far homogenised this new actor group

(Grippa, Schmittmann, and Suntheim 2019; Gunningham 2020; Langley and Morris 2020). This heterogeneity both on the organisational and the individual level begs further explaining, however. It also calls for the tracing of its impacts on policy choices, policy effectiveness, unintended consequences as discussed in the fourth paper of this thesis, and wider network effects given that – as highlighted above – central bankers engage in collaborative and not just isolated modes of governance.

Despite central bankers' creativity and heterogeneity in governing the finance-climate nexus, this PhD suggests a certain element of continuity and homogeneity throughout the processes leading to the creation of the TCFD, the development of the TCFD recommendations, and the design of the NGFS reference scenarios: Central bankers have not taken the position to use prudential supervisory powers to mitigate climate change. The assessment and eventual mitigation of climate risk is the mission pursued by central bankers throughout the papers of this PhD. As highlighted in countless speeches by central bankers, anything else would simply not be their responsibility but the responsibility of governments and parliaments (Coeuré 2018; Galhau 2021; Lagarde 2021). This leaves central banks in the current awkward position of explicitly not filling a governance vacuum left by other state institutions while still sufficiently intervening in financial market practice to create the impression of central banks as active participants in the climate governance space – an impression very much nurtured by acts of NGFS members e.g. to publish a declaration with the caption “Committed to Action” at COP26 in Glasgow (NGFS 2021). Whether the initial scrutiny by journalists when Carney elevated the profile of climate risk or whether the NGO criticism of the use of negative emission technology in the NGFS reference scenarios – central banks are perceived and addressed as climate governors (see also Langley and Morris 2020). Central bankers in turn do not accept this position and deflect responsibility back to governments. The avoidance of issues perceived as political, i.e. as belonging to the realm of governments and parliaments, in the TCFD recommendations – e.g. climate lobbying – or in the NGFS scenarios – e.g. the missing of governments' climate targets – traced in this PhD again highlight this ambivalent position of central banks. This PhD thus echoes and adds to concerns in the literature on regime complexes highlighting accountability and effectiveness issues where responsibilities are fragmented or not clearly assigned (Abbott 2012; Biermann et al. 2009).

From a governance perspective, this ambivalence bares the question of how central banks obtained this position of virtually filling a governance vacuum – the governing of the relationship between finance and the planet's climate – but substantially avoiding it. To what degree can the dominance of central banks within the FSB (see Mackintosh 2017) explain why not e.g. finance ministries took on this governance task? Does the virtual presence of central banks crowd out other potential governors? The question ‘Why central banks?’ is not just of intellectual interest but relevant to understand potential roadblocks – or opportunities – in creating a governance architecture effectively governing all

dimensions of the relationship between finance and climate. It is not obvious that central banks can in fact be “climate governors of last resort” (Langley and Morris 2020). They might be the climate governors of first resort, however, mirroring the reliance of governments on central banks during the 2008 financial crisis and the Covid-19 pandemic (see e.g. Tooze 2021). As long as central banks in turn rely on the frame of climate risk to understand climate change and to interpret their relationship with the planet’s climate, there is a need to accompany and critically interrogate its construction.

6.2.2. To ANT

6.2.2.1. *On materiality & relationality*

Materiality, relationality, and how these two pillars of ANT connect and relate lies at the heart of what the sociology of translation is (Latour 2005; Muniesa 2015). ANT stipulates – in short – that the material world is productively and powerfully involved in constituting the relational by stabilising relations across time and space thus allowing to act at a distance (see e.g. Latour 2005, 194–99). Whether as stable objects, i.e. immutable mobiles (Latour 1987, chapter 6), or as changing and shifting fire or water objects (Law and Mol 2001; Law and Singleton 2005), the material world is what supports relational stability.

This PhD questions this privileged position of non-human materiality in solidifying the relational within ANT. As discussed in the first paper, face-to-face (F2F) interactions can be instrumental in building lasting actor-networks. Repeated personal interactions can result in bonds of trust stabilising relations. While living like a baboon society by interacting F2F is considered impractical and even impossible in the context in ANT (Callon and Latour 1981; Latour 2005, 202–4), it becomes relevant again as stabiliser and mode of relating in the context of finance and transnational governance (see also MacKenzie 2004). These findings are not to be generalised across e.g. all of finance. A rich literature on market (e.g. Callon, Millo, and Muniesa 2008) and valuation devices (e.g. Doganova 2020) demonstrates the central role objects can play in economic agencements. This PhD nuances this debate by demonstrating how particular environments – e.g. the environments of early-stage innovation in financial governance – afford F2F interaction greater significance in constituting agency. Such F2F interaction still has a crucial material dimension of course. The materiality of human bodies somewhat fills the gap left by the absence of suitable non-human objects. Thus, while findings in the first paper of this PhD call for an extension and not an abandoning of ANT’s conception of materiality and how it relates to relationality, they point to a larger problem. As Clark (2020) notes, ANT’s focus on the immediate relational practice between the human and the non-human world might create blind spots for other types of relations such as for relations far away in terms of time or relations exclusively between non-human actors, e.g. different animal species. This PhD extends this concern to relations exclusively between human actors, i.e. not materially mediated relations.

Where the first paper makes explicit and discusses the mode and dynamics of such purely human relation building, the following two papers at multiple points hint towards how humans in fact become stabilisers of relations. In paper two, TCFD members stabilise through their professional role and their personal interactions with peers the TCFD's relation with 'the market' while the TCFD Secretariat ensured that the legal mandate binding both financial supervisors and the TCFD effectively demarcated the boundaries of the TCFD's work ousting, for instance, corporate lobbying activity as not relevant for climate risk. In paper 3 it is central bankers actively avoiding political decisions therefore stabilising the legal relation of neutrality between their respective central bank and their government while scientists in persona stabilising relations within their own profession by resorting to scientific caution. Thus, it appears that in practice, it is not always written mandates, physical documents granting material presence to definitions of relations. Certain relations come to structure translation primarily by virtue of having been internalised by human actors.

This leads to the discussion of interests in the second paper. While ANT's sensibilities provide a useful basis for identifying heterogeneous interests, locating, and localising them, it lacks a thorough conceptualisation of their origin (Lave 2015, 218–19). Given the prominence that interests have within ANT motivating and steering translation attempts in the first place, this is problematic. While Latour (2005, 204–18) does address the constitution of subjectivity, his account of individuals simply being actor-networks themselves interconnected through so-called plug-ins 'downloaded' to make up an individual combination of connections to what actually lies outside of the *individuum* leaves open some central questions. How do individuals formulate interests in the face of contradicting 'plug-ins' if they lack any truly own agency? Are relationships constituted by plug-ins really subjected to the same trials of strength as relations crafted in science laboratories or academic conferences and journals (Callon 1986, 211; Latour 1987, chapter 2)? ANT's focus on relationality and materiality might have left a wide gap in its conceptual framework where one might expect a conceptualisation of the self.

While ANT has often been criticised for its lack of attention to values, norms, ideologies, and beliefs (see e.g. Jasanoff 2004, 22–23), this PhD thus helps to understand such shortcomings of ANT not as problem as such but as symptoms of the underlying pathology of an under-conceptualisation of the human self. Findings on how humans – by internalising relations as noted above – can stabilise relations themselves is not a fatal blow to ANT's conception of how stability in modern societies is achieved. They do not question the relevance of objects but demand symmetrical attention to the constitution of the self as immutable or mutable mobile. This PhD through findings scattered across all three empirical papers thus allows to reconceptualise and therefore hopefully make more productive a well-known critique of ANT. This reconceptualization invites theoretical engagement and empirical experiments with combining ANT with relational ontologies of the self. Such combination might create

a bridge to critical social theories grounding their critiques of what is typically conceptualised as structures in micro-foundations of the relationally constituted self (Deranty 2009; such as e.g. Honneth 2007).

6.2.2.2. *On power & critique*

This PhD has demonstrated how ANT can facilitate critique and make relations of power visible while redefining its limits in doing so. Its sensibilities allowed to reveal heterogeneous types of power relations – in paper 1 – and unexpected interest constellations – in paper 2 – not typically detected in the literature. Its radical empiricism and attention to the micro-level in both cases helped to formulate more precise critique, foregrounded the specific of the empirical reality at hand rather than the abstracted general. The common critique of ANT-based approaches then, however, questions whether this focus on the specifics, the unique, does not actively cloak reoccurring patterns characterising more than the particular case at hand, i.e. the structural (Koddenbrock 2014; Roberts 2011). “In other words, the focus on the ‘concrete and contingent’ obscures the tendency of the real historical constellation of capitalism to impose its ‘necessary’ logic and contradictions on society. It is futile to study the configuration of socio-technical agencements as long as alternative configurations do not change the underlying model of capitalist accumulation” (Braun 2016, 262). This PhD rebuts this criticism in three ways joining and extending more conciliatory accounts in e.g. critical human geography on the potential of ANT to facilitate critique (Castree 2002; Holifield 2009).

First, and most trivially, the third paper shows how ANT’s sensibility to the material identifies certain model and database features as stabilising an unequal capacity to assess climate risk and a future perpetuating historical distributions of GHG emission cuts between the Global North and the Global South. Thus, regardless of the fundamentally different conceptions of critique, ANT can produce insights on the kind of structural inequalities often neglected within ANT according to critics (such as e.g. Lave 2015).

Second, as discussed in more detail in the first paper and flagged in the third, a lack of critique of what critics conceptualise as structure, context, or the macro-level is rooted not necessarily in conceptual shortcomings of ANT making such critique impossible. It rather results from practical limitations of research budgets, time constraints, or field access. Such a diagnosis then calls for a treatment of the problem of critique different from an immediate return to potentially reified and empirically detached concepts of structure understanding the social as the *explanans* rather than the *explanandum* (Latour 2005; Mills 2018, 291–96). The treatment instead needs to take the form of transparency of the research process, of where the tracing of a tie stopped, and which ties were not followed at all. These ‘loose ends’ (paper 3) can then be traced in the context of a wider, inclusive, and collaborative research agenda such as the one outlined in the fourth paper of this PhD for the subject of climate risk.

Third, critique is always rooted in a specific normative standpoint (Castree 2003, 289–94). ANT as such does not prescribe a normative standpoint which some critics conflate with the separate observation that many key representatives of ANT such as Michel Callon do not take normative positions in their research (see e.g. Mills 2018, 297–300). While such criticism conveniently ignores where such representatives do take strong normative – and radical – stances (e.g. Latour 2018), it fails to convincingly argue why the empirical substance and the normative assessment need to be delivered in one and by the same author. ANT's aspiration is to unveil ontological politics in such detail that a true democratization of world-making becomes possible, i.e. that all normatively meaningful choices become visible as such and can be debated as such (Clark 2020, 160; Law 2008, 637–38; Mol 1999). The immanent critique of the NGFS reference scenarios as not being financially stressful enough and the needs-based critique of those scenarios neglecting ideas of redistribution and justice between the Global North and the Global South in the third paper were developed from one single ANT account, for instance. Similarly, the account of the TCFD's origins and workings in the first and the second paper can serve as basis for a wide range of critique. Each empirical paper in this PhD demonstrates that an ANT approach does neither foreclose nor formulate critique; it facilitates it by unveiling ontological politics.

6.2.2.3. *Reflections on the usefulness of ANT*

While this thesis draws on and advances ANT, it also stresses its limits. This poses the question of whether ANT – ex post – can still be considered a useful framework in the context of this particular PhD. Without in any way suggesting that the TCFD, the NGFS scenarios, or the construction of climate risk could not be studied productively employing other conceptual frameworks, this sub-section seeks to highlight how exactly ANT facilitated insights and what might have gone undetected without an ANT approach.

On the most general level, ANT has proven useful in the context of this PhD by helping to understand a wide range of vignettes of the research object which might have blurred under a more totalising lens. This usefulness is at least partially conditional on a conception of ANT not as 'puristic' but as flexible set of sensibilities (Law and Singleton 2013) as outlined in the introduction. The more ANT is understood as elaborate methodology rather than as a theory, the more it allows the researcher to enhance it with concepts from other theoretical schools (Venturini 2010). The first paper demonstrates this by bringing findings from economic geography to bear on the ANT blind spot of face-to-face interaction and the third paper does so by 'plugging' insights from a diverse literature on imagining futures into a basic ANT framework.

The third paper also highlights another way in which ANT proved useful for this PhD. As Doganova (2020) argues in the context of valuation devices, ANT helps and guides the researcher to investigate

the ‘inside’ of such devices, i.e. asking how something is being calculated. Furthermore, ANT allows to apply this sensitivity broadly, not just limiting it to market devices but to valuation devices in the wider sense. Without such ANT guidance, the third paper might have not engaged with the range of models underpinning the NGFS scenarios in such depth or detail.

ANT’s flat ontology facilitated this research in helpful ways as well. The avoidance of ex-ante conceptions of relevant actors and the sensitivity to the heterogeneity of actants and actors helped – across all empirical papers – to appreciate the complexity and the multi-layered nature of the research object (see Bled 2010 for a similar account). Without this aspect of the ANT framework, the first paper might have stopped at the level of organisations and institutions, conveying a story of central banks, the FSB, and French and UK state agencies, missing out on the formative level of individuals interacting face-to-face. The third paper might have focused exclusively on models without relating them to the organisational and institutional logics and dynamics of central banks. ANT helps to see and seamlessly integrate such heterogeneity within actor-networks.

Finally, ANT proves perhaps most useful in that it understands facts as outcomes of controversies being closed down rather than being replaced by consensus (see Lidskog and Sundqvist 2015). In doing so, ANT pushes the researcher to problematise rather than to naturalise facts, fixtures, and routines. It always prompts the question whose voices were silenced and whose voices prevailed in the creation of the status quo. Combined with what Law (2004) calls the ‘baroque’ perspective of foregrounding the details and understanding complexity through the small rather than the large, ANT led this research to uncover chains of ontological politics throughout all three empirical papers. The dual nature of climate risk – as physical and transition risk – is shown to be the achievement of closing down voices advocating for the inevitability of limiting GHG emissions in the first paper. The second paper explains how the TCFD framework now instructing mandatory disclosure requirements globally relied on the muting of diverse voices – some effectively opposing a systemic view of climate risk and some advocating for a climate alignment vision. Finally, the third paper unveils a wide range of climate futures excluded from finance’s imagined climate futures to make the governance technology of the NGFS scenarios work. Thus, ANT is instrumental in this PhD to bring out and analyse the two sides of ontological politics: the political effects of world-making, i.e. of constructing (knowledge about) the world in particular ways, and the political contestations preceding the achievement of the status of a fact or a black box (Mol 1999; Voß and Freeman 2016).

6.3. Implications

6.3.1. For future research

As emphasized before, this PhD does not only answer but also raise a series of questions for future research. The fourth paper in this thesis develops an entire research agenda for a sociology of climate risk spelling out a series of research questions on silo formation, path dependencies, and performative effects of climate risk calculation, on the economization dynamics upstream and downstream of said calculation, and on alternative problematisations of climate change within finance. While far-reaching and inclusive, this research agenda can be supplemented or spelled out in greater detail based on some of the more particular findings of this PhD speaking to a diverse range of scholars.

On imagined futures

Scholars working on the imagination of futures can bring their analytical lenses to bear on three sites where futures are brought into the present. First, the further development of the NGFS reference scenarios as central mediator between the present and the future for finance should be accompanied academically to answer questions such as: How persistent are the exclusions identified in the third paper of this PhD? Do new vintages of the scenarios carry imprints of new exclusions? How and for what purpose do individual central banks employ or adapt the reference scenarios? How is this mediated by resource constraints, involvement in the scenario design process, their respective domestic political environments, and other factors?

Second, other centres of calculation should be investigated as the NGFS does not have a monopoly on the imagination of climate futures in finance. Big or specialised consultancies, organisations such as the International Energy Agency (IEA), and academic institutions create an eco-system of imagining climate futures for and/or within finance. These sites of imagination need to be researched both individually and as an interconnected and interdependent whole. What are the obligatory passage points (OPP) in each site or in the network as a whole? What exclusionary are other kinds of dynamics do these OPPs give rise to?

Third, research is needed on how scenarios and other forms of present climate futures are translated into strategies and decisions within banks, insurance companies, consultancies, pension funds, and asset managers. How do different actors in different sites negotiated their relationship with time differently when devising strategies (Doganova and Kornberger 2021)? Under what circumstances and how is uncertainty turned into fragmented futures stalling decisions and action and how is it turned into calculable risk or made knowable, manageable, or thus actionable in other ways? How do guidelines and frameworks such as the TCFD recommendations constrain and enable the imagination of climate futures and their translation into strategies and decisions within different organisations?

On governance

Exploring the role of central banks and the TCFD as governors of the finance-climate nexus, this PhD raises a wide range of questions of interest to governance scholars. First, research questions can be formulated on the level of the overall climate governance landscape. For instance, how does the entry of central banks into the polycentric climate governance regime complex affects its overall structure (Abbott 2012)? Might central banks complement, attract, or crowd out other potential governors of the finance-climate nexus such as parliaments or international organisations? If, for instance, finance ministries have chiefly relied on the frame of market failures to enter the climate space (Skovgaard 2012), have they now been replaced by central banks who strive to 'fix' market failures to manage climate risk? The impact of central banks in the climate governance regime complex might extend beyond the finance-climate nexus. To what extend do governance modes established in finance such as a reliance on industry, e.g. in the context of the TCFD, or on technocrats such as central bankers replace a culture of democratic legitimization historically more common in the environmental space (see e.g. Dingwerth 2007, 191)? Do features of the climate risk frame or governance tools such as the NGFS scenarios – narrowed down and adapted to the needs and priorities of finance – 'leak' into the wider climate governance regime? With COP26 seeing a whole day dedicated to the financial sector, scholars of global environmental governance should pursue questions around the potential colonization of climate governance by finance.

Furthermore, this PhD raises question on the conditions under which new governance institutions emerge thus altering the climate governance landscape. Given the challenges to functionalist approaches this PhD formulates, more research is needed to explore the role of individuals and their interactions in creating new governance institutions. More specifically, scholars researching the emergence of governance institutions need to address the question to what extent a given governance problem definition precedes individuals' efforts to set up or identify a suitable governance institution, or to what degree individuals adapt their problem definition to the needs, priorities, and beliefs of the governance institution targeted – as in the case of climate risk being specifically fashioned to land with central banks. Such questions call for detailed process tracing of changes in the climate governance regime complex.

Beyond questions on the landscape of climate governance, this PhD also raises questions on the mode and effects of governance. For instance, comparative research within and between multi-stakeholder initiatives (MSI), expert bodies, and other transnational governance institutions could illuminate the conditions under which organisational or individual interests shape policy designs and decisions. Focusing on the TCFD which still remains active and issues training material and guidance on its recommendations, questions on its legitimacy arise. How does the TCFD maintain – or potentially lose

– its “liquid authority” over the interpretation and extension of its original recommendations (Black 2017)? Also, in the light of this PhD’s findings research on the effects and effectiveness of the TCFD recommendations needs to go beyond assessments of disclosures. While valuable in their own right (see e.g. Bingler et al. 2022), they do not address the question of whether or not the TCFD achieved the goal of transforming underlying organisational practice formulated by many TCFD members. This question could be addressed in multiple ways ranging from multi-sited ethnography to quantitative assessments of disclosure-induced portfolio changes as done in the context of French disclosure regulation (see Mésonnier and Nguyen 2021).

With ANT

For ANT scholars, this PhD poses two main questions. First, it challenges them to explore when and where people and/or the materiality of their bodies matter. Put more broadly, where and under what conditions are we faced with a baboon society rather than a world of objects (Callon and Latour 1981; Latour 2005, 194–99; MacKenzie 2004)? How can ANT adapt to such circumstances, e.g. by accounting for the materiality of human bodies, and where does it reach its limits?

The concept of limits leads to the second question posed to ANT scholars: How can what this PhD calls loose ends in ANT research be made visible to the reader? What are practical strategies and techniques which make transparent and explicit where the tracing of ties stops? Given the relevance of this definition of boundaries and limits of ANT research discussed above and throughout this PhD, this question is critical. While Latour (2005, 133–35) recommends tedious documentation of the research process resonating with calls in social science for generating an ‘audit trail’ of qualitative research (see e.g. Nowell et al. 2017), this does not address the issue of communication. A pile of detailed notebooks and hundreds of pages of meeting minutes and reflexions can easily become a simulation rather than a realisation of transparency where no reader or scholar could ever find the time to engage with this vast amount of research documentation. Thus, what are practical methods to simplify, condense, or visualise an ANT research process highlighting its limits and loose ends?

While the last set of questions targeting ANT scholars might be timeless, the other research questions are perhaps the opposite. Researchers are currently in the privileged position to witness, explore, and analyse the design of climate futures and their governance and with it the emergence of path dependencies *in vivo*. This is a unique opportunity for documenting and understanding contestations before they are closed down, identifying choices and alternative realities before they become hidden by ex-post rationalisation and conceptions of necessity and inevitability, i.e. to analyse and critique the ontological politics of climate risk, climate futures, and climate governance.

6.3.2. For policymakers and practitioners

This PhD was never intended to produce concrete and actionable ‘policy insights’ but to advance understanding. In doing so, however, this PhD has produced a knowledge base that can be instructive for policymakers. Especially for central bankers this PhD identifies issues worth reflecting on. Most generally, this PhD identifies a series of concrete choices made both in the TCFD disclosure framework and in the NGFS scenarios which could be taken differently. From the choice of discount rates to the calculation of downscaled carbon emission pathways and the neglect of companies’ lobbying activities – this PhD points to a myriad of normative choices which remain normative whether legitimised by mandates, mathematical models, or academic credentials. This opens up the possibility for a conscious engagement with these issues rather than black-boxing them and thus not just hiding them from public scrutiny but also withholding them from a close examination through the lens of prudential supervision. What risks, for instance, are central bankers missing when they ignore companies’ lobbying activities or the planet’s climate tipping points? Also, the identification of such concrete issues provides the opportunity to develop in more detail ideas of introducing alternative approaches in financial supervision such as the precautionary principle (Chenet, Ryan-Collins, and van Lerven 2021) or a wider understanding of systemic risk (Bolton et al. 2020). While such approaches have been formulated in abstract terms, applying them to the choices and issues identified in this PhD could advance the debate by making it more concrete, similar to the application of the precautionary principle to the estimation of unreported corporate GHG emissions by Hoepner and Rogelj (2021).

Regarding the design of climate scenarios, it is worth emphasizing the call for its democratisation formulated in the third paper of this PhD. The exclusionary dynamics flagged in that paper are clearly connected to the dangers of silo formation and path dependencies described in more theoretical terms in the fourth paper and could result in systematic biases in the estimation of climate risk. They also enshrine injustices and specific values and interests into a governance tool which should serve the public interest. Involving a wider range of specialist views in the scenario design process could be a first step to tackle these issues.

Lastly, as noted in the third paper of this thesis, it seems plausible that the current NGFS climate scenarios underestimate climate risk, especially catastrophic climate risk. With climate scenario exercise results from the UK and from France showing non-trivial but also no concerning effects of climate risk on financial stability, the optimistic scenario design could become a liability for central banks’ legitimacy to operate in the climate space. Regulators cannot justify going ‘too low’ in regulating risks for too long (Black and Baldwin 2012). Hence, there might be a trade-off for central bankers between gaining legitimacy through a scenario design process that tends to produce lower-risk

scenarios and loosing legitimacy by constructing climate risk as manageable and absorbable within the current financial structures.

For a wider range of policymakers, the first paper in this PhD holds a potentially instructive lesson – especially in the context of a global pandemic which shifted many interactions into the virtual space of video calls. In short, in-person interactions can narrow gaps between world views, i.e. how individuals perceive certain aspects of the world around them. Thus, especially during early stages of innovation and of bridging wide gaps in understanding and views – including between specialist communities such as climate modellers on the one hand and central bankers on the other hand – face-to-face interaction can prove critical. Interacting in person can – from a purely functional perspective – accelerate decision-making but also build the trust and generate opportunities to ask questions and raise topics which do not make it onto a formal Zoom call agenda.

The second paper might prove relevant for policymakers in the space of MSIs, expert advisory bodies, or other comparable governance institutions. By highlighting the potential impact of individual interests on the policymaking process, it questions whether organisational affiliations or professional backgrounds are sufficient criteria for gauging the role a person could play within a given governance institution.

Finally, the fourth paper of this PhD clearly spells out an insight relevant for any practitioner in the climate risk space: Wherever models and metrics are being design or used, it is pivotal to build reflexive organisational structures to prevent, unveil, and tackle unintended consequences and perverse effects resulting from silo formation, path dependencies, or performative dynamics. This PhD in its findings – e.g. by identifying the facilitative role face-to-face interaction can play in knowledge translation – as well as in its constructive critique – e.g. by calling for diversifying the specialist voices in the NGFS scenario design process – provides some building blocks for such a reflexive organisational structure.

Many of these implications share a common thread which lies at the heart of this PhD: the imperative to consciously and openly – meaning transparently and inclusively – engage with the ontological politics of the finance-climate nexus. Epistemic world-making must not be left to what Latour (2018, 33) calls “sleepwalkers” following outdated scripts from a time preceding the Anthropocene. Only by making ontological politics visible can we see – and decide – what other worlds are possible.

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