# Corporate Action on Climate Change: Perspectives on Time, Risk, and Value

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Thesis submitted for the degree of

Doctor of Philosophy in Geography and the Environment

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Hilary Term 2022

*For my Family.*

## Abstract

Companies are increasingly under pressure from governments, investors, and consumers to act on climate change by reducing, and ultimately eliminating, carbon emissions (decarbonisation). Yet companies continue to be held accountable for generating strong financial results and safeguard, if not maximise, shareholder value. This raises an important question: How do companies act on climate change in the face of intensifying decarbonisation and ongoing commercial imperatives? This thesis examines corporate action on climate change through three complementary perspectives on time, risk, and value. Drawing on economic geography, organisation and management, and accounting research, the thesis investigates: (1) the relationship between organisational time orientation and corporate carbon emissions; (2) how companies reconcile institutional demands to reduce carbon emissions (climate-stewardship logic) with pressures to create shareholder value (market logic); and (3) the determinants and capital market implications of corporate climate risk disclosures.

The thesis finds that (1) long-term oriented companies generate less carbon emissions, (2) companies reconcile market and climate-stewardship logics by transforming the system-level problem of climate change into the managerial – and thus manageable – object of climate risk, and (3) self-reported corporate climate risk exposures are largely not reflected in stock market values. Together, these insights shed light on the antecedents, processes, and consequences of corporate action on climate change, an issue that has received limited attention by economic geographers to date. Overall, this thesis provides evidence on the contours of an emerging carbon economy through the eyes of its central actors – companies in carbon-intensive industries – and highlights the importance and potential of researching the ways in which companies navigate and shape the transition to a low-carbon economy.

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## List of Abbreviations

| | |
|---|---|
| CDS | Credit Default Swap |
| CEO | Chief Executive Officer |
| CFTC | U.S. Commodity Futures Trading Commission |
| $CO_2$ | Carbon Dioxide |
| CSR | Corporate Social Responsibility |
| ESG | Environmental, Social, and Governance |
| ETS | Emission Trading System |
| EU | European Union |
| FSB | Financial Stability Board |
| GHG | Greenhouse Gas |
| O&M | Organisation & Management |
| R&D | Research & Development |
| TCFD | Task Force on Climate-Related Financial Disclosures |

## Acknowledgments

To begin with, I would like to thank my supervisors, Dr Caitlin McElroy and Dr Anette Mikes, for their invaluable support throughout this DPhil project. To Caitlin, for your steadfast guidance in navigating this DPhil journey, for giving me the liberty to pursue my research interests, and for your excellent advice on pulling everything together in this thesis. To Anette, for sharing your curiosity and enthusiasm for research with me, for giving me ample opportunities for development, and for your outstanding mentorship. This DPhil project has also benefitted greatly from my collaboration with Prof Elizabeth Demers. To Liz, thank you for all your guidance and support – I have learned a lot from you. I'm also grateful for the advice I received from Prof Richard Barker and Dr Aoife Brophy at various stages of this project.

I would like to express my gratitude for the financial support I received from St Edmund Hall, Oxford University. Thanks also goes to Judith Stroehle for three years of fruitful collaborations on various research projects at Saïd Business School (SBS), Oxford University. My work as a research assistant at SBS was not just a pillar of financial support but a source of inspiration for my DPhil project.

This research was made possible by everyone who generously contributed insights during research interviews, and I would like to thank all participants for their time and willingness to be part of my research. I was fortunate to share my time in Oxford with friends and colleagues who have enriched my life and work. Thank you especially to Sergio, Elena, and Lena for your support and companionship on this DPhil journey. There are many reasons why I am glad that my path led me to Oxford, but the most important one is that I have met you here, Kasia. Thank you for bringing so much joy and happiness to my life. I also owe many thanks to Dee and Richard for welcoming me so warmly in their home and providing a haven during the pandemic.

Finally, there are no words to express my gratitude for the infinite support and love I have received from my family over all these years. To my parents Adriane and Armin, my sister Sonja, my grandmas Ulla and Marianne, and my aunt and uncle Beate and Wolfgang – this thesis is as much your achievement as it is mine, for none of it would have been possible without you.

# 1 Introduction

## 1.1 Corporate Action on Climate Change

Global surface temperature levels have increased by approximately 1°C since the onset of the industrial revolution and the atmospheric carbon dioxide concentration has reached the highest level in two million years (IPCC, 2021). Rising temperature levels increase the risk of triggering severe environmental changes with potentially catastrophic impacts on natural and human systems (IPCC, 2014a, IPCC, 2018). In fact, human-induced climate change is already affecting weather and climate extremes across the globe, manifesting in the increased frequency and severity of heatwaves, droughts, tropical cyclones and other extreme weather events (IPCC, 2021). To limit further global warming and mitigate severe climate impacts, global anthropogenic carbon emissions need to reach net zero around 2050 (IPCC, 2018). This requires the reduction of carbon emissions to zero either by removing carbon from the atmosphere (e.g. through emission offsetting or carbon capture and storage solutions) or by eliminating carbon emissions at the source (Millar, Allen, Rogelj, & Friedlingstein, 2016). Achieving such a steep reduction, and eventual elimination, of carbon emissions requires fundamental transformations of how we produce, consume, and, more broadly, organise our economies. The mitigation of and adaptation to climate change necessitates a transition from climate-forcing assets[1] that accelerate climate change to climate-saving assets that enable a net zero economy, while safeguarding assets that are vulnerable to physical climate impacts (Colgan et al., 2021; Paterson, 2021).

As key economic actors holding, controlling, and operating these different types of assets, companies play a central role when it comes to climate change adaptation and mitigation.

[1] Following Colgan et al. (2021), assets are understood to be „a broad category that includes all inputs to production and sources of material wealth: capital, labor, and natural endowments." (Colgan, Green, & Hale, 2021, p. 586).

Companies holding climate-vulnerable assets can have substantial exposure to the physical impacts of climate change, where insufficient adaptation measures can pose an existential threat to businesses and stakeholders. For example, Pacific Gas and Electric (PG&E), California's largest electric utility, filed for bankruptcy in 2019 in the face of billions of dollars in potential liabilities after the California Department of Forestry and Fire Protection found that the company's faulty power lines caused multiple wildfires in 2017 and 2018, resulting in the deaths of 86 people and the destruction of thousands of buildings (MacWilliams, Lamonaca, & Kobus, 2019). Dubbed the world's first "climate-change bankruptcy" (Gold, 2019), the PG&E case illustrates the potentially devastating effects of insufficient corporate adaptation measures on the viability of businesses and communities at large.

While the attention to companies' ability to support or hinder societal adaptation to climate change is relatively nascent (Averchenkova, Crick, Kocornik-Mina, Leck, & Surminski, 2016; Goldstein, Turner, Gladstone, & Hole, 2019; Linnenluecke, Griffiths, & Winn, 2013), there is a long-standing awareness of the differentiated, and often contested, roles of companies in mitigating climate change. On the one hand, companies command considerable financial, technological, and knowledge resources that are important for developing the climate-saving assets that are critical for achieving a net zero economy. On the other hand, companies are also in control of climate-forcing assets, which need to be phased out to decarbonise our economy and reach net zero emissions. Those companies have an interest in maintaining the (carbon-intensive) status quo to protect the economic viability of their carbon-forcing assets. Oil and gas companies, for example, have known for decades about the dangers of climate change but aggressively pursued strategies to publicly attack climate science and obstruct or delay meaningful policy changes that would harm their business models (Bonneuil, Choquet, & Franta, 2021; Oreskes & Conway, 2010; Supran & Oreskes, 2017). Looking back on the past decades of unmitigated emission and temperature rises, one must contend that holders of climate-forcing assets have been extraordinarily successful in protecting their economic interests and fending off substantial policy changes.

However, change is under way. In 2015, nearly 200 countries negotiated the Paris Agreement and pledged to limit global temperature increase to between 1.5 and 2 °C above pre-industrial levels. Since then, climate change concerns have skyrocketed and governments, investors, and civil society have stepped up the pressure on companies to reduce carbon emissions and support the transition to a low-carbon economy. Recent years have seen the emergence of a global youth movement calling for ambitious climate action, governments enshrining net zero emission targets into law, and investors pressuring company boards to set more ambitious emission reduction targets. It is important to note that these developments are geographically differentiated, with Europe in many ways being the epicentre, but commitments to mitigate climate change are by no means confined to European countries. At the time of writing, 136 countries and 641 companies have set net zero emission targets, covering at least 88% of global greenhouse gas emissions, 90% of global GDP (assessed in purchasing power parity terms) and 85% of the world's population.[2]

The dynamics propelling climate change to the top of corporate agendas are not limited to aspirational rhetoric, they are also driven by material changes in the economy. Chief among them is the precipitous fall of the costs of renewable energy generation in recent years, making renewable energy the lowest-cost energy option in many regions of the world (Chase, 2022). For example, the costs for utility-scale solar installations declined by 82 percent in the period of 2010–2019 and the cost of 56 percent of all newly commissioned utility-scale renewable power generation capacity in 2019 was lower than that of the cheapest fossil-fuel-fired option (IRENA, 2020). Simultaneously, the cost of emitting

[2] https://zerotracker.net/

carbon has increased in many parts of the world, with carbon pricing initiatives covering 21.5% of global carbon emissions in 2021, up from 15.1% in the previous year. In the European Union (EU), the price of emission allowances (from here on, “carbon price”) has risen from €8 in early 2018 to €90 in December 2021. The soaring carbon price has been flanked by a host of ambitious EU climate policies designed to accelerate the decarbonisation of the economy (European Commission, 2021).

These developments can be interpreted as early signs of a shift from a world where the need to combat climate change was much talked about, but rarely acted on, to a world that is getting serious about transitioning to a low-carbon economy. This shift has profound consequences for businesses, in particular for those that control and operate climate-forcing assets. With climate change mitigation efforts beginning to reshape market dynamics in favour of low-carbon activities, companies come under pressure to decarbonise their business model and operations. Importantly, these pressures are not merely reputational, they are increasingly economic and, in some cases, existential, as markets begin to reconfigure the costs and benefits of climate-saving vice versa climate-forcing assets. For example, the push for decarbonising heavy industry in the European Union poses an existential challenge for European steel companies, as they face escalating carbon prices, a lack of cost-competitive low-carbon steel manufacturing technologies, and the inability to pass on higher productions costs to customers. In contrast, steel companies in geographies without comparable carbon pricing regimes are largely shielded from these pressures and, in fact, might even indirectly benefit from them by being able to offer lower prices than their European competitors on global commodity markets.

For all the changes that have increased the pressure on companies to reduce carbon emissions, another factor has remained largely constant and exacerbated the complexity that companies face in navigating the transition to a low-carbon economy: companies are still held accountable for generating strong financial results and safeguard, if not maximise, shareholder value. Although it is often argued that demands for emission reductions and shareholder value creation are compatible (Porter & Kramer, 2006, 2011), it is not clear if and when the relationship between climate and financial performance is complementary or contradictory (e.g. Busch & Hoffmann, 2011; Busch & Lewandowski, 2018; Delmas, Nairn-Birch, & Lim, 2015; Lewandowski, 2017). The empirical evidence is mixed, indicating that companies can profitably reduce their emissions under certain circumstances, while in other contexts – in particular in the case of companies holding climate-forcing assets – emission reductions come at the expense of financial performance (Hart, 1995; Hart & Dowell, 2011). This raises an important question: How do companies reconcile the increasing pressure to reduce carbon emissions with the constant demand for creating shareholder value? This question is all the more important as there are few signs that companies have achieved significant carbon emissions reductions to date (CDP, 2015; Dietz et al., 2021; Doda, Gennaioli, Gouldson, Grover, & Sullivan, 2016) and, on a global level, emissions have continued to rise largely unabated over the last decade (Peters et al., 2020).

In light of this, the purpose of this thesis is to gain a better understanding of corporate action on climate change, that is, how do companies act on climate change in the face of intensifying decarbonisation and ongoing commercial imperatives. As a society we place great emphasis on the significance and need for business to help change the trajectory of climate change – and yet we know very little about whether and how companies do this successfully in practice. Straddling social and natural sciences, geography – and economic geography in particular – is principally well suited for studying corporate action on climate change (Clark, Feldman, Gertler, & Wójcik, 2018; Taylor & O'Keefe, 2021). And while research in economic geography has generated valuable insights into the evolution and functioning of market-based governance approaches to climate change (Bailey, Gouldson, & Newell, 2011; Boyd, Boykoff, & Newell, 2011; Boykoff, Bumpus, Liverman, & Randalls, 2009; Knox-Hayes, 2016), this literature has surprisingly little to say about the behaviour and actions of the actors who are arguably one of the key addressees of these governance structures – companies. With few exceptions (e.g. Ormond, 2015; Walenta, 2018), companies have been treated as a black box and their inner workings, strategies, and impacts on climate change have received limited attention in economic geography.

Although the role of companies in driving, mitigating, and adapting to climate change has been explored in adjacent social science disciplines such as organisation and accounting studies, there are still substantial blind spots calling for more research on corporate action on climate change. First, the physical materiality of climate change – and the natural environmental more broadly – remains underappreciated in organisational research (Bansal & Knox-Hayes, 2013; Whiteman, Walker, & Perego, 2013) and a surprisingly small number of studies have empirically examined how organisational features shape companies' impacts on climate change in the form of corporate greenhouse gas emissions (Dahlmann, Branicki, & Brammer, 2017; Ioannou, Li, & Serafeim, 2016). Second, there are signs that climate change is increasingly framed as an organisational risk (Bui & Villiers, 2017; Kumarasiri & Gunasekarage, 2017; Pinkse & Gasbarro, 2019; Weinhofer & Busch, 2013), yet the actual processes, tools, and expertise involved in mediating between these climate risk perceptions and corporate action on climate change constitute a black box (O'Dwyer & Unerman, 2020).

Third, capital markets can either punish or reward companies for their (in)action on climate change. Although there is an extensive body of work examining the determinants and capital market implications of climate-related disclosures (Hahn, Reimsbach, & Schiemann, 2015), prior research is limited to investigating carbon emissions as a proxy of the risks that companies face related to climate change (e.g. Jung, Herbohn, & Clarkson, 2018; Matsumura, Prakash, & Vera-Muñoz, 2014, Bolton & Kacperczyk, 2021). However, carbon emissions are at best an indirect and incomplete proxy of corporate climate risk exposure, since it primarily captures policy risks (e.g. carbon pricing schemes) and ignores a host of other climate risks that range from extreme weather events to changes in technology or consumer behaviour. More research is thus needed to understand whether and how more holistic climate risk disclosures are reflected in companies' stock market values.

Addressing these research gaps and gaining a better understanding of corporate action on climate change is important for numerous reasons. At a fundamental level, companies are key actors in our economic, capitalist system and their fates are intimately connected with the socioeconomic viability of communities, regions, and nations (Schoenberger, 1997). Moreover, as this thesis will argue, companies are significant ecological actors whose actions, literally, shape the face of the earth and alter the planet's atmosphere. Corporate activities are major sources of carbon emissions and thus key drivers of anthropogenic climate change (Ekwurzel et al., 2017; Heede, 2014). The actions of companies – in particular of those holding climate-forcing assets – will make or break the transition to a low-carbon economy and determine whether the increase of global temperatures can be limited to between 1.5 and 2 °C above pre-industrial levels.

In addition to its ecological significance, corporate action on climate change has important socioeconomic implications. Limiting further climate change requires an unprecedented reorganisation of economic systems centred around the transition from climate-forcing to climate-saving assets. How companies navigate and shape this transition has wide-ranging ramifications for the socioeconomic landscapes in which they are embedded. The accelerating transition from combustion engine to electric vehicles, for example, poses a monumental challenge to the automotive industry in Germany, which employs more than 800 000 people and comprises an intricate network of car manufacturers and automotive suppliers – many of which are specialised in supplying combustion engine components. The success or failure of these companies to navigate the low-carbon transition has profound impacts on industrial structures, employment, and the prosperity of surrounding communities and regions. The transition to a low-carbon economy is, of course, not merely a function of *corporate* action, but a complex dance between different societal actors that is riddled with divergent motivations, interests, and conflicts. Yet this thesis contends that companies are powerful actors in driving, mitigating, and adapting to climate change and it is thus important to gain better insights into the conditions and processes that shape their actions on climate change.

### 1.1.1 Perspectives on Time, Risk, and Value

This thesis proposes that the categories of time, risk, and value provide useful analytical lenses for examining corporate action on climate change. All three categories are fundamental aspects of social life and feature prominently in economic and other social scientific inquiries. For example, value is a central concept in economics and the history of economic thought can be understood as an evolving discourse between rival theories of value (Roncaglia, 2005). Indeed, references to risk, time, and value abound – and often overlap – in economic approaches to explaining human behaviour. To illustrate the relevance of these three interlocking categories for analysing corporate action on climate change, it is useful to consider economic perspectives on *intertemporal choices*, that is, "decisions involving tradeoffs among costs and benefits occurring at different times" (Frederick, Loewenstein, & O'Donoghue, 2002, p. 351). Choices with consequences in multiple time periods are a ubiquitous feature of life and have received considerable attention in economics. While economist have thought about intertemporal choices since the early days of the discipline – Adam Smith, for example, highlighted the importance of intertemporal choice for the wealth of nations – a generalised approach to modelling intertemporal choices emerged only in 1937 in form of the Discounted Utility model (Samuelson, 1937). The key assumption of the model[3] is that people assess the consequences of a decision by "exponentially 'discounting' the value of outcomes according to how delayed they are in time" (Berns, Laibson, & Loewenstein, 2007, p. 482). In other words, according to the Discounted Utility model, people place a lower *value* on future outcomes than on present outcomes and they do so for a variety of reasons, including the *risk* that future outcomes may not materialise (Hashimzade, Myles, & Black, 2017). The example of temporal discounting is not only useful for illustrating the overlapping relevance of time, risk, and value as analytical categories in economics, but it also points to the relevance of these categories for thinking about corporate action on climate change. The remainder of this section introduces how this thesis leverages time, risk, and value as analytical lenses for examining corporate action on climate change.

*Time*

Climate change is about time. Although the impacts of a rapidly changing climate are already manifesting today, many of the most significant impacts will unfold over the coming decades and centuries (Pahl, Sheppard, Boomsma, & Groves, 2014; van Renssen, 2019). Likewise, the climate impacts we are witnessing today are the consequence of carbon dioxide released into the atmosphere in the past. This time lag between the causes

[3] The Discounted Utility model was quickly accepted as a normative basis for policy making and an accurate description of human behaviour, dominating economic thinking about intertemporal choices for much of the 20th century (Frederick, Loewenstein, & O'Donoghue, 2002). However, research in psychology has found little empirical support for the validity of the Discounted Utility model (Frederick, Loewenstein, & O'Donoghue, 2002; Loewenstein & Prelec, 1992). In response, studies examining intertemporal choices have blossomed into a vibrant field of research that has developed a wide range of alternative, empirically-grounded intertemporal choice models (e.g. Read, McDonald, & He, 2018). Although these models differ from the initial formulation of the Discounted Utility model, many of them retain the basic logic of modelling intertemporal choices with alternative specifications of discount rates (see, for example, hyperbolic discounting).

and effects of climate change is a consequence of the long lifetime of carbon dioxide in the atmosphere. Short of actively removing carbon dioxide from the atmosphere, a significant fraction of emitted carbon remains in the atmosphere for centuries and locks in corresponding mean surface temperature levels over this time span (Knutti & Rogelj, 2015). Even if an immediate elimination of carbon emissions prevented further temperatures rises, the effects of any warming that has already occurred (e.g., melting of ice sheets) would continue for generations.

These lagged effects of climate change, in turn, necessitate the urgency in reducing, and ultimately eliminating, carbon emissions and achieving the necessary decarbonisation of economic activities requires significant investments by companies to replace climate-forcing with climate-saving assets (Stern, 2011). Companies thus need to incur costs in the present (deploying finance, expertise, equipment, and other resources) to achieve an outcome in the future (eliminated emissions). Taking action on climate change thus poses an intertemporal choice problem that is characterised by "decisions in which the timing of costs and benefits are spread out over time" (Loewenstein & Thaler, 1989, p. 181). How companies respond to intertemporal choice problems is influenced by organisational time orientation (Laverty, 1996, 2004; Reilly, Souder, & Ranucci, 2016), which is defined here as the importance that organisations attribute to the past, present and future (Bluedorn, 2002). The perception of time is therefore a critical variable that shapes how companies act on climate change (Sarasini & Jacob, 2014; Slawinski & Bansal, 2012, 2015; Slawinski, Pinkse, Busch, & Banerjee, 2017). To better understand the relationship between organisational time orientation and corporate climate action, the first paper of this thesis examines whether long-term oriented companies are more likely to invest in decarbonisation measures that result in lower carbon emissions.

*Risk*

The relevance of risk for corporate action on climate change is closely related to perceptions of time, since the very notion of risk is constituted at the interface between present and future:

> "[R]isk refers to events that have not yet happened, that may perhaps never happen at all, or that may lead to results different from what is expected. Risk, in this sense, is constituted in the face of a future that remains undecided: open to anxiety, surprise, struggle and aspiration. Risk creates cross-temporal linkages by turning such anxieties and aspirations into drivers of current activities" (Müller-Mahn, Everts, & Stephan, 2018, p. 207).

Risk is thus central to the understanding of climate change as a problem that requires urgent action. For example, the objective enshrined in the 2015 Paris Agreement to limit global warming to between 1.5 and 2 °C above pre-industrial levels is predicated on the notion that doing so will mitigate the risk of future environmental changes threatening to destabilise human and natural systems (IPCC, 2018). In other words, "[r]isks are relationships of possible adversity, calculated and assessed by someone for some specific purpose using some specific means" (Garland, 2003, p. 53). Why, how, and for whom something is constructed as a risk matters, because it shapes how actors respond to it (Adams, 2002). The ways in which climate change is framed in terms of risk has thus important implications for how companies and other actors take action on it (Hultman, Hassenzahl, & Rayner, 2010; O'Dwyer & Unerman, 2020). The second paper of this thesis unpacks how companies come to understand climate change in terms of risk and examines the role of accounting practices in mediating the relationship between perceptions of and action on climate change.

*Value*

The understanding of climate change in terms of risk involves identifying something as a threat (e.g. global warming) to something that is considered to be of value (e.g. natural systems). From this relational perspective, risk is not an objective fact but the outcome of socially situated cognitive processes in which actors construct something as a risk (Boholm & Corvellec, 2011; Douglas & Wildavsky, 1982; Hilgartner, 1992). In recent years, the notion of climate risks has gained significant currency among companies, investors, and other capital market participants. This has been partly driven by regulatory concerns over climate change as a source of structural change that might trigger substantial and unforeseen changes in the value of financial assets, which could lead to a destabilisation of financial markets (Carney, 2015). Both the physical phenomenon of climate change as well as society's response to climate change have been identified as risk factors that pose a threat to the viability of economic activities and, by extension, to the value of financial assets (NGFS, 2019). To preserve financial stability and prevent climate risks from triggering sudden changes in asset valuations, the Financial Stability Board – an international body comprised of national banks and finance ministries – established the Task Force on Climate-Related Financial Disclosure (TCFD) to facilitate greater transparency around the financial impacts of climate-related risks (and opportunities) on companies' income statements, cash flow statements, and balance sheets. In 2017, the TCFD published a set of recommendations for companies to disclose information about their exposure to and management of climate risks (TCFD, 2017b).

The premise underpinning enhanced climate risk disclosure is that it prevents mispricing of climate risks in capital markets, facilitates more efficient capital allocation, and, ultimately, enables a smooth transition to a low-carbon economy (Carney, 2015; TCFD, 2017b). According to this approach, the provision of relevant climate risk information enables market participants to accurately value climate risks and adjust their behaviour accordingly, hence preventing abrupt changes in valuations of financial assets (Carney, 2015). Although climate risk is here narrowly defined with reference to financial value, the question of how financial market participants assess corporate climate risk exposure is relevant for corporate action on climate change in at least two ways. First, investors are powerful stakeholders that can shape corporate strategies, board compositions, and other significant organisational features through shareholder proposals or direct engagement with companies' senior management teams. Greater awareness of climate risks among investors can thus be a key channel through which companies receive pressure to reduce their carbon emissions and mitigate climate risks. Second, the perception of the value relevance of companies' climate risk exposure can influence companies' access to capital (Flammer, Toffel, & Viswanathan, 2021), which in turn impacts the ability of companies to invest in existing and new business activities. Put differently, financial markets can serve as a feedback mechanism that either rewards or punishes companies' actions on climate change. The third paper of this thesis empirically tests this feedback mechanism by examining the determinants and capital market implications of corporate climate risk disclosures.

## 1.2 Chapter Contents

The objective of this thesis is to shed light on corporate action on climate change through three perspectives: time, risk, and value. In line with this problem-oriented approach, the thesis follows a paper route and comprises three distinct research papers that constitute chapters 3, 4, and 5 respectively. While all three papers address the issue of corporate action on climate change, each paper draws on different theoretical resources, employs different methods, and speaks to different, but related, scholarly communities. With its focus on studying the interplay between companies and climate change, the thesis is grounded in economic geography and the discipline's commitment to understanding human-environment relations (Clark et al., 2018). While the research interest spans social (organisational action) and physical phenomena (climate change), the key unit of analysis is the firm. This thesis thus engages with adjacent fields of social scientific inquiry in the empirical studies that form the core of the DPhil research project at hand. These fields are first and foremost organisation & management (O&M) and accounting research, and each paper leverages field-specific theoretical resources, methodologies, and discourses to examine corporate action on climate change. The first paper on time draws on the organisation and (strategic) management literature to investigate the relationship between organisational time orientation and corporate climate action; the second paper on risk combines institutional theory and sociological perspectives on accounting to explore companies' strategic responses to climate risk; and the third paper on value is situated in (financial) accounting oriented value relevance studies that are concerned with empirically investigating the relationship between corporate disclosures and stock market values.

The common denominator of these papers – and the cornerstone of the thesis – is corporate action on climate change and the question how companies reconcile the increasing pressure to reduce carbon emissions with the constant demand for creating shareholder value. Seeking to answer this question, the thesis undertakes a journey that begins with the recognition that the ultimate arbiter of effective climate action is the concentration of carbon dioxide in the atmosphere. To limit global warming, further increases in the atmospheric concentration of carbon dioxide need to be minimised, which requires the rapid reduction of carbon emissions from human activities. This brings into sharp focus that, ultimately, the key benchmark for assessing the effectiveness of corporate action on climate change is the amount of carbon that companies release into the atmosphere. The focus on the impact of companies on climate change constitutes the starting point of the thesis and the first paper employs statistical analyses to examine the relationship between organisational time orientation – defined as the importance that organisations attribute to the past, present and future (Bluedorn, 2002) – and corporate carbon emissions. As such, the paper adopts an inside-out approach that explores the role of organisational factors (time orientation) in shaping companies' impact on climate change (carbon emissions).

But how do companies come to understand climate change as an issue that requires attention, and eventually action, in the first place? This is the guiding question of the second paper of this thesis (Chapter 4), which opens the organisational "black box" and explores how companies grapple with the increasingly complex interplay between their impacts on climate change (inside-out) and the impacts of climate change – and societal efforts to mitigate it – on their businesses (outside-in). For instance, companies with high carbon emissions have a large impact on climate change and, simultaneously, those firms are more likely to be substantially impacted by measures aimed at reducing carbon emissions (e.g. carbon pricing). The second paper sheds light on how companies frame these two-way climate impacts in terms of risk and opportunities and the ways in which those framings – mediated by internal accounting representations – give rise to different actions in the form of four climate-response strategies.

The third research paper constitutes Chapter 5 of the thesis and investigates corporate action on climate change from the perspective of the third theme of this thesis – value. Adopting an outside-in approach, this paper examines how the voluntary disclosure of climate risk exposure is reflected in the stock market values of publicly listed companies. The motivation for exploring how capital markets incorporate climate risks into firm valuations emerged from interviewing corporate managers about the perception and management of climate risks during the research underpinning Chapter 4. Most interviewees highlighted investors as one of the key drivers that had pushed climate risks higher up on corporate agendas. However, pressure from investors was often attributed to a relatively small group of shareholders and questions were raised to what extent capital markets have actually integrated companies' climate risk exposure into firm valuations. The third research paper examines this question. Table 1.1 provides an overview of the three core chapters and the remainder of this section summarises each chapter in terms of background, approach, results and discussion, and conclusions.

**Table 1.1: Overview of Core Chapters**

| | Chapter 3 | Chapter 4 | Chapter 5 |
|---|---|---|---|
| Thesis Topic | | Corporate Action on Climate Change | |
| Perspective | Time | Risk | Value |
| Approach | Inside-Out | Inside-Out & Outside-In | Outside-In |
| Method | Panel data econometrics | Multiple case study | Panel data econometrics |
| Discipline | O&M | O&M and Accounting | Accounting |
| Targeted Journal[4] | Organization & Environment | Accounting, Organization and Society | European Accounting Review |
| Collaborators | Single-authored | Dr Anette Mikes | Dr Elizabeth Demers |

### 1.2.1 Chapter 3

*Title:* It's about time? The role of temporal orientation in corporate climate change mitigation

*Background:* The world is warming at an unprecedented scale and speed and human-induced climate change is already affecting weather and climate extremes across the globe (IPCC, 2021). To limit further global warming, companies need to rapidly reduce, and eventually eliminate, carbon emissions (IPCC, 2018; Millar et al., 2016). The urgent need for drastic emission reductions stands in stark contrast to the slow uptake of effective climate action by companies (CDP, 2015; Dietz et al., 2021). Prior organisation and management (O&M) research has identified organisational time perspectives as an important antecedent of corporate action on climate change (Sarasini & Jacob, 2014; Slawinski & Bansal, 2012, 2015). More recently, these findings have been combined in a conceptual framework that outlines how short-term oriented time perspectives manifest in organisational contexts and lower the propensity of companies to take effective climate action that achieves durable emission reductions and results in lower corporate carbon emissions

[4] All three chapters have been submitted to these peer-reviewed publication outlets.

(Slawinski et al., 2017). It is unclear, however, whether this postulated relationship between time perspectives and carbon emissions holds true empirically.

*Approach:* The chapter follows recent research emphasising the importance of time in corporate action on climate change (Bansal & Knox-Hayes, 2013; Slawinski et al., 2017; Slawinski & Bansal, 2012, 2015) and examines the relationship between organisational time orientation – defined as the importance that organisations attribute to the past, present and future (Bluedorn, 2002) – and corporate carbon emissions. Organisational time orientation is measured as (1) temporal focus of CEOs, (2) time orientation of executive compensation (forward-looking targets; sustainability factors), and (3) time orientation of ownership structure (percentage of short-, medium-, and long-term oriented shareholders). I hypothesise that long-term oriented companies are more likely to invest in decarbonisation measures and thus have lower corporate carbon emissions (Slawinski et al., 2017). To test this hypothesis, the chapter estimates a fixed effect regression model of a sample of 68 European companies in carbon-intensive industries in the period of 2010-2018.

*Results and Discussion:* Consistent with the hypothesised relationship between organisational long-term orientation and corporate carbon emissions, the chapter finds that long-term oriented CEOs and long-term oriented shareholders are negatively associated with corporate carbon emissions. However, the chapter finds that the integration of sustainability incentives in executive remuneration packages is positively – rather than negatively – associated with carbon emissions, suggesting that companies with sustainability-linked incentives for executives have higher – instead of lower – corporate carbon emissions. This surprising finding might reflect a more symbolic rather than substantive use of sustainability-linked incentives (Bowen, 2014), where companies integrate sustainability criteria into executive compensation to signal a superficial environmental commitment rather than to incentivise effective action on climate change (Berrone & Gomez-Mejia, 2009). Finally, there is no statistically significant association between the inclusion of forward-looking targets into executive compensation and corporate carbon emissions.

*Contributions:* First, the chapter is one of the first studies to provide empirical support for the proposition that long-term oriented companies are more inclined to take effective climate action and thus have lower carbon emissions (Slawinski et al., 2017). Second, the chapters responds to calls for organisation and management (O&M) research to pay close attention to the ecological impacts of companies (Whiteman et al., 2013; Winn & Pogutz, 2013). With its analytical focus on the influence of organisational time orientation on corporate carbon emissions, the chapter places the ecological impacts of companies at the heart of the analysis and provides novel empirical insights into the ways in which organisational features shape companies' impacts on climate change (Dahlmann et al., 2017; Ioannou et al., 2016). Third, the chapter contributes to the growing literature on the role of time in organisations and strategic management, which has been largely focused on examining companies in a North American context. However, perceptions and experiences of time differ between cultural settings (Bluedorn, 2002) and examining European firms thus adds insights into the time-climate change nexus from outside North America.

### 1.2.2 Chapter 4

*Title:* Climate Risk as Linguistic Cleansing: Strategic Responses to the Climate Crisis by Carbon-Intensive Corporations

*Background:* Companies are increasingly under pressure from governments, investors, and consumers to respond to climate change by substantially reducing carbon emissions (decarbonisation). This logic of climate stewardship has gained prominence in recent years (Ansari, Wijen, & Gray, 2013), with policymakers in Europe stepping up their efforts to curb carbon emissions. For instance, a European Climate Law came into force in

2021, which includes a legally binding target and supporting policies to reach net-zero emissions in the EU by 2050 (European Commission, 2021). Yet companies continue to be held accountable for generating strong financial results and safeguard, if not maximise, shareholder value. Although it is commonly suggested that companies can satisfy both demands for decarbonisation and financial performance, it is not clear empirically if and when the environmental-financial–performance relationship is complementary or contradictory. This study thus explores the following question: How do carbon-intensive companies reconcile growing institutional demands to reduce emissions (a climate-stewardship logic) with the constant pressure to create shareholder value (a market logic)?

*Approach:* Based on a multiple case study of 19 European carbon-intensive companies in the chemical, steel, and utility industries, this chapter examines how companies respond to the dual pressures of the emerging climate-stewardship and the dominant market logic. The empirical focus on these three industries was chosen due to the typically high–carbon-emission operations of companies in these industries, making them a particularly pertinent setting for investigating how companies navigate simultaneous institutional demands for decarbonisation and profit. Adopting an abductive approach to analysing the empirical material (interview and archival data) for the case companies, the study draws on two conceptual frameworks to derive its findings. First, it builds upon work of Oliver (1991) and Pache and Santos (2010; 2013) to identify companies' strategic responses to the nexus of climate-stewardship and market logics. Second, it draws on a framework proposed by Kurunmäki, Mennicken, and Miller (2016) – the "triptych" of quantifying, economizing and marketizing – to explain the role of calculative practices in companies' efforts to reconcile the climate-stewardship and the market logics.

*Results and Discussion:* The study identifies four different types of strategic responses to the climate crisis. (1) *Green Transition Strategy*: explicit alignment of business model with climate-stewardship logic by aspiring to deliver low-carbon products through core businesses; (2) *Green Segmentation Strategy*: partial alignment of business model with climate-stewardship logic through certain low-carbon product segments; (3) *Engagement Strategy*: lobbying policymakers and other stakeholders for support to decarbonise business; (4) *Defensive Strategy*: focus on communication measures to deflect decarbonisation pressures and protect carbon-intensive business model. These four different strategic responses were associated and shaped by distinct conditions and calculative practices. In terms of conditions, the chapter finds that the ratio of climate-saving to climate-forcing assets was an important factor influencing the strategic response to climate change, with companies holding more (less) climate-saving assets that were either less carbon-emission–intensive or that directly facilitated carbon emission reductions experienced less (more) tension between commercial and climate-stewardship logics.

Another important element shaping the strategic response of companies was the use of calculative practices that enabled the envisionment and quantification of threats, costs, and opportunities associated with the climate-stewardship logic. As such, calculative practices were implicated in reformatting climate change as *climate risk* and, thereby, creating a new management object that transformed the seemingly intractable system-level problem of climate change into an issue manageable by companies. Allowing companies to reconcile the climate-stewardship and the market logics, the chapter proposes that the "managerialization" of the climate crisis was accompanied by a performative act of *linguistic cleansing* (Barnhizer, 2013), a language control strategy deployed by adherents of the market logic that reshapes the moral, management, and ideological imperatives surrounding corporate action on climate change.

*Contribution:* The study makes two contributions. First, it extends research on how organisations respond to pluralistic institutional demands or logics (e.g. Oliver, 1991; Pache

& Santos, 2010; Pache & Santos, 2013) by focusing on the role of calculative practices in reconciling the climate-stewardship logic and the market logic. Whereas extant research on institutional complexity has emphasised leadership practices as an important element of organisational efforts to reconcile institutional logics, this study examines strategic responses to institutional complexity as a dynamic alignment of institutional demands and companies' contextual and idiosyncratic predispositions (e.g. the ratio of climate-forcing to climate-saving assets). This dynamic alignment is mediated by accounting practices that are implicated in creating decarbonisation rationales that feed into internal investment processes and external policy engagements.

Second, the study contributes to work on the "quantifying, economising and marketising" of public and organizational life (Kurunmäki et al., 2016; Miller & Power, 2013) by examining how companies reformat climate change as climate risk to reconcile tensions between the market and the climate-stewardship logics. The study proposes that organisational risk management plays a dual role in reconciling these institutional logics. Risk management blends the market (opportunity) logic with the social imperative logic of decarbonisation and, thereby, reformats a system-level problem (climate change) into a managerial—and seemingly manageable—object (climate risk). Simultaneously, risk management shifts the underlying logic of appropriate governance from a predominantly state-driven response to climate change (i.e. climate stewardship by regulating corporate actors) to a primarily market-driven response enacted by corporate actors with various degrees of dependence on governmental support (i.e. market logic enacted by largely self-regulating corporate actors).

### 1.2.3 Chapter 5

*Title:* TCFD Climate Risk Disclosures: Early Evidence on the "Gold Standard"

*Background:* In recent years, concerns over the negative implications of climate change for financial stability have gained currency among capital market participants, standard setters, and regulatory bodies (Carney, 2015; NGFS, 2019). Despite a flurry of activity in the sustainability disclosure space, investors have complained for years that they lack adequate information to assess companies' exposure to climate risk (Herren Lee, 2021; Krueger, Sautner, Starks, & Karolyi, 2020). This dearth of climate risk information is somewhat surprising, since the disclosure recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD) have been available since 2017 (TCFD, 2017b). Globally recognized as the "gold standard" for climate-related disclosures (Mooney & Nauman, 2020), the TCFD framework aims to facilitate corporate disclosures about the impacts of climate change on companies (e.g. extreme weather events) rather than companies' impacts on climate change (e.g. carbon emissions).

The impacts of companies on climate change has long been the focus of voluntary and mandatory climate-related disclosures and there is an extensive body of research examining the determinants and capital market implications of carbon emission disclosures (e.g. Jung et al., 2018; Matsumura et al., 2014, Bolton & Kacperczyk, 2021, amongst many others). However, focusing on carbon emissions alone yields only a partial picture of companies' climate risk exposure, since it primarily captures policy risks emanating from more stringent external carbon pricing schemes (e.g. emission trading systems or carbon taxes) and ignores other climate risks that range from extreme weather events to changes in technology or consumer behaviour. Adopting such a comprehensive understanding of climate risks, this chapter examines the determinants and stock market value implications of voluntary disclosures made in accordance with the TCFD reporting framework.

*Approach:* The chapter includes two subsequent sets of analyses of a global sample of 3,856 publicly listed firms from developed economies[5] and South Africa. First, the study investigates the determinants of firms' decisions to provide TCFD-aligned disclosures. Drawing on economics-based theories of disclosure (e.g. Milgrom, 1981; Verrecchia, 1983) and previous research on voluntary environmental disclosures (Christensen, Hail, & Leuz, 2021), it is expected that a number of firm characteristics will influence voluntary climate risk disclosure, including firm size, asset mix, financial structure, ownership and governance characteristics, the firm's industry and region of headquarters, as well as various indicators of the firm's commitment to sustainability and environmental performance. To test the relationship between these determinants and voluntary climate risk disclosure, a probit regression is estimated where the outcome variable is an indicator that is set to one if firm *i* in period *t* chooses to provide TCFD-aligned disclosures.

A second set of analyses examines whether TCFD-aligned disclosures are associated with companies' stock market values. More specifically, the value relevance of three different climate risk disclosures is analysed: (1) the mere act of disclosure, operationalised as an indicator variable set to one if a company provides TCFD-aligned disclosures; (2) the number of transition and physical climate risk[6] disclosed; and (3) the estimated financial impacts of climate risks disclosed by the firm. Consistent with information asymmetry and signalling theories (Healy & Palepu, 2001), the expectation is that the provision of climate risk disclosures reduces the information asymmetry between companies and

[5] Based upon the listing of advanced economies provided by the IMF (International Monetary Fund, 2020b).
[6] The TCFD disclosure framework distinguishes between two types of climate-related risk: i) risks related to the *transition* to a lower-carbon economy; and ii) risks related to the *physical* impacts of climate change (TCFD, 2017b, p. 5).

investors and signals an enhanced ability to measure and manage climate risk. Hence, it is hypothesised that the provision of climate risk disclosures will be associated with higher market value, ceteris paribus.

*Results and Discussion:* Running the first set of analyses, the study finds that firm size, institutional ownership, indicators of the firm's commitment to sustainability, industry membership, and geographical region are significant determinants of voluntary climate risk disclosure. In addition, corporate environmental performance is also an important determinant for the subset of firms for which this data is available. In the second set of analyses, the study finds that the mere act of providing climate risk disclosure is not reflected in market value, suggesting that the provision of climate risk disclosure alone is not a sufficiently credible signal of the firm's commitment to, or success in, measuring and managing climate risks. When considering the information content of climate risk disclosures, the results indicate that the number of transition risks disclosed by firms is negatively associated with firm value, consistent with the market treating these as credible and material threats to the firm's business model and future prospects (i.e., as unrecorded liabilities or impaired assets). However, neither the number of physical risks disclosed nor the estimated financial impacts of climate risks is associated with firm value.

*Contribution:* This chapter is one of the first studies to present large-sample evidence related to the voluntary disclosure of climate risks. The analyses are important because demand for sustainable investment has been exploding in recent years and investors are clamouring for relevant, reliable, and consistently measured climate-related information. As regulators and standard setters step up efforts to *mandate* climate risk disclosures, the findings suggest that the "gold standard" of *voluntary* climate risk disclosure is largely not being reflected in share prices. This suggests that (1) investors don't perceive the disclosed climate risk exposure as a threat to firm prospects, (2) investors either don't understand or process the disclosed information, or (3) investors simply don't pay attention to corporate climate risk disclosures.

## 1.3 Methodology

Consistent with the problem-oriented approach of this thesis, the three empirical chapters forming the core of the thesis leverage the full spectrum of social science methodologies to examine corporate action on climate change. The choice of quantitative and qualitative methods was guided by the specific problem at hand, that is, each chapter uses those methods that were deemed best suited to answer the respective research question. As such, the thesis pursues a data-driven, empirical approach that is grounded in pragmatism as a paradigm for social research (Morgan, 2014).

Pragmatism as a philosophical movement emerged in the late 19th and early 20th century through the work of Charles Sanders Peirce (1839–1914), William James (1842–1910) and John Dewey (1859–1952).[7] Although there is considerable variety and difference in opinion among these figures, they shared common beliefs that have come to be labelled as American or classical pragmatism. A central – and perhaps the most important – theme of pragmatism is anti-foundationalism. Instead of viewing ideas as transcendent, fixed truths, classical pragmatists argued that the truth of ideas was established through the accomplishment of particular tasks: "Ideas were labelled true when they enabled us to get things done, when they coped effectively with the world." (Barnes, 2008, p. 1544). The emphasis on the practicality and usefulness of ideas is coupled with a view of the world as being comprised of multiple realities that are open to various forms of inquiry (Feilzer, 2010). Pragmatism thus proposes arguments about truth and reality that are different from post-positivist and constructivist philosophies of knowledge. Whereas the latter posit that

[7] A themed issue on pragmatism and geography published in Geoforum provides a useful overview of the commonalities and differences among the key proponents of classical pragmatism (Wood & Smith, 2008).

reality either exists independently of our understanding of it or that reality is constructed by our understanding, pragmatists acknowledge both perspectives as valid claims about how we experience the world: “On one hand, our experiences in the world are necessarily constrained by the nature of that world; on the other hand, our understanding of the world is inherently limited to our interpretations of our experiences.” (Morgan, 2014, p. 1048)

Pragmatism as a research paradigm thus sidesteps the dichotomy of constructivist and positivist approaches to research, opening a variety of ways for conducting scientific inquiries that span conventional boundaries of quantitative and qualitative research methods (Feilzer, 2010). Instead of determining research methods ex ante through metaphysical assumptions about the nature of truth and reality, a pragmatic choice of methods is guided by the question “will this help me find out what I want to know?” (Hanson, 2008, p. 109) It is in this pragmatic spirit that the research for this thesis was designed and executed.

The empirical research design in Chapter 3 is tailored to examining the relationship between organisational time orientation, effective climate action, and corporate carbon emissions. Using a sample of 68 publicly listed European companies operating in carbon emission intensive industries (GICS Industry Groups: Energy, Mate-rials, Utilities), I estimate a fixed effect regression model that removes the effects of any time invariant firm factors and allows for estimating the net effects of organisational time orientation on corporate carbon emissions (Allison, 2009). Standard errors are clustered at the firm level and year fixed effects are included in the model to account for heteroscedasticity, serial autocorrelation and contemporaneous correlations (Certo & Semadeni, 2006). The data for this analysis was retrieved from Thomson Reuters EIKON and S&P Capital IQ databases.

Corporate carbon emissions – the outcome variable – is measured as metric tons of $CO_2$ equivalents by a company in a given year. This measure includes direct emissions from sources directly owned by companies (Scope 1) and indirect emissions from the generation of purchased energy (Scope 2). To account for the skewed distribution of corporate carbon emissions, the natural logarithm of carbon emissions is used in the regression analysis. Organisational time orientation – the explanatory variable – is measured on three dimensions (individual, organisational, institutional) by a set of variables. On the individual dimension, the variable *CEO future focus* measures the importance that the CEO of a company attributes to the future. This measure is based on a computerised text analysis of CEO speech extracted from earning conference calls with investors. On the organisational dimension, the time orientation of executive compensation is measured by the indicator variables *long term compensation* and *ESG compensation*. The former is set to one if the remuneration of management and board members is partly linked with targets that are more than two years forward-looking (set to zero otherwise) and the latter is set to one if a company has an executive compensation policy that includes sustainability or Environmental, Social, and Governance (ESG) factors (set to zero otherwise). On the institutional dimension, the variable *long-term investors* measures the percentage of shareholders with annual portfolio turnover rate less than or equal to 50% and average holding periods longer than two years.

Chapter 4 transitions to a different mode of inquiry and employs a comparative case study approach to examine how companies' understanding of climate change in terms of risk is formed and mediated by organisational processes and accounting practices. The research setting is comprised of 19 publicly listed European companies in the chemical, steel, and utilities industries, since these firms are particularly exposed to institutional demands for carbon emission reductions due to the high carbon-intensity of their business models and the ambitious climate policy agenda in the European Union. The study draws on two complementary data sources. First, data was collected in 26 semi-structured interviews with sustainability, strategy, finance, and risk managers from the 19 case companies included in the study. Second, the interview data was triangulated by collecting annual reports, sustainability reports, press releases and responses to the 2019 CDP Climate Change Questionnaire.[8] Consistent with the pragmatic research design of this thesis, Chapter 4 pursues an abductive approach to data analysis, deriving some of the codes from extant literature (deductive step) while also allowing new codes to emerge from the empirical material (inductive step). The findings presented in Chapter 4 are thus the outcome of iteratively going back and forth between data and extant theory (Clark, 1998).

The methodology of Chapter 5 returns to econometric panel data analyses to examine the determinants and capital market implications of voluntary climate risk disclosure. Studying a global sample of 3,856 publicly listed firms from developed economies[9] and South Africa, the chapter comprises two subsequent sets of analyses. First, a probit regression is estimated to investigate the determinants of three corporate disclosure decisions, including whether to respond to the CDP questionnaire, whether to disclose climate risks in accordance with the TCFD framework, and whether to provide estimates of the TCFD-solicited financial impacts of climate risks, respectively. The outcome variable is alternatively an indicator that is set to one if a firm in a given year chooses to respond to the CDP questionnaire (*CR*), to provide TCFD-compliant climate risk disclosure (*CR*), or to provide the TCFD-solicited estimates of the financial impact of climate risks on the firm (*FI*), and zero otherwise. The model includes 15 explanatory variables and standard errors are clustered by firm and year in all specifications.

[8] CDP is a nonprofit organization that operates a corporate environmental disclosure system and gathers data on corporate action on climate change.
[9] Based upon the classification of advanced economies provided by the IMF (International Monetary Fund, 2020b).

In a second set of analyses, Chapter 5 estimates a pooled regression to examine whether any of the three corporate disclosure decisions are associated with firm value. Tobin's Q, defined as the market value of common equity plus the book value of debt, all scaled by the book value of total assets, is used as the outcome variable to capture firm value. To test the value relevance of corporate climate risk disclosure, three model specifications with different explanatory variables are estimated, including (1) indicators that are set to one when each respective disclosure (*CDP*, *CR*, *FI*) has been provided, (2) the number of disclosed climate risks, and (3) the estimated financial impacts of climate risks disclosed by a firm in a given year. A set of control variables is included in all models and standard errors are clustered by firm and year.

To conclude the introduction to this thesis, some remarks on the spirit in which this DPhil project has approached the issue of corporate action on climate change. The thesis is informed by a pragmatic view of companies' role in acting on climate change, that is, the thesis acknowledges that corporate activities, in many ways, are key drivers of climate change and companies are thus a substantial part of the problem. Yet the thesis also recognises the significance of companies as social actors that commanding extensive resources and expertise that have the potential to be part of the solution, that is, mitigating climate change. As such, the thesis neither aligns with managerial perspectives that uncritically accept the legitimacy, and sometimes superiority, of companies' role in combatting climate change, nor does the thesis subscribes to views of companies as culprits destined to further the accelerating climate and ecological breakdown. Instead, the thesis views companies as complex and differentiated social actors that are principally capable of driving, mitigating, and adapting to climate change. The purpose of this thesis is then to shed light on *how* companies act on climate change by considering the categories of time, risk, and value as interrelated challenges of corporate action on climate change.

# 2 Literature Review

The thesis engages and contributes to different but related bodies of literature across various social science disciplines to examine corporate action on climate change. Chapters 3, 4 and 5 each include a dedicated literature review that position the research in the respective disciplinary discourse. The purpose of the literature review at hand is to provide a backdrop to the in-depth discussions included in the subsequent chapters and establish the role of companies in driving, mitigating, and adapting to climate change as a multi-disciplinary object of study. Studying the interface between companies and climate change is about studying human-environment relations. Geography, and economic geography in particular, is well suited to this task since it straddles social and natural sciences (Clark et al., 2018; Taylor & O'Keefe, 2021). This literature review thus begins with an exploration of how climate change has featured in the economic geography literature. Documenting the insights of economic geographers into the evolution and functioning of market-based governance approaches to climate change, the review finds that this literature has surprisingly little to say about the behaviour and activities of the actors who are arguably one of the key addressees of these governance structures and occupy a central role in economic processes – companies. This is reflective of the limited attention that firms have received in economic geography at large (Maskell, 2001; Taylor & Asheim, 2001). The second part of the literature review thus turns towards organisation studies to conceptualise companies as socio-ecological actors that are spatially and temporally embedded in nature and society. Highlighting the organisational and social significance of accounting, the third part introduces accounting studies as another body of research that this thesis leverages to examine corporate action on climate change.

## 2.1 Economic Geography Perspectives on Climate Change

Economic geography is dedicated to “explaining the spatiality of economic processes and the diversity of economic life they create” (Clark et al., 2018). For much of the twentieth century, the engagement of economic geography with environmental issues was largely limited to exploring the role of resources in economic processes, with a particular focus on questions around primary commodities (e.g. oil, wood, etc.) as economic input factors (Angel, 2000; Bakker, 2012). Following calls for a broader engagement with contemporary environmental phenomena and in lockstep with growing societal concerns about the detrimental environmental impacts of economic activities (Bridge, 2008a; Hayter, 2008; Soyez & Schulz, 2008), environmental issues have become increasingly central to economic geography over the past two decades, as reflected in the introduction to the New Handbook of Economic Geography:

> “The broad definition of economy in economic geography also recognizes that economy is embedded in society and nature, relying on social and natural resources and processes. As such, human–environment relations are central to economic geography, just as they are to geography in general." (Clark et al., 2018, p. 1)

Climate change has featured prominently in the ascent of environmental issues on economic geography research agendas and the remainder of this section will focus on reviewing these climate change-related studies. The majority of this research has been concerned with examining climate change mitigation, that is, societal efforts to reduce carbon emissions. In this context, work in economic geography has focused in particular on the emergence of the *carbon economy* as a phenomenon produced by market-based governance approaches to controlling and reducing carbon emissions (Boykoff et al., 2009). Although first attempts to trade carbon emission reductions as financial instruments on markets can be traced back to the late 1980s (Boyd et al., 2011), the creation and use of market instruments to facilitate carbon emission reductions gathered pace and became mainstream in the 2000s (Knox-Hayes, 2016). While the specific design and implementation of carbon markets is geographically differentiated (Knox-Hayes & Hayes, 2014), they are underpinned by a common belief that climate change can be mitigated through technocratic solutions of measuring and pricing carbon emissions in economic markets (Knox-Hayes, 2018).

The creation and operation of carbon markets is a complex enterprise and economic geographers have generated valuable insights into various aspects of the carbon economy, including the processes and governance structures involved in converting carbon emission reductions into tradable commodities (Bumpus, 2011; Bumpus & Liverman, 2008), the organizations and relationships involved in building the institutions and infrastructure of carbon markets (Knox-Hayes, 2010), and ancillary practices of carbon markets such as accounting and disclosure of carbon emissions (Knox-Hayes & Levy, 2011; Lovell & MacKenzie, 2011; Pattberg, 2012). Work in economic geography has also critically examined the political implications and material consequences of carbon markets, highlighting, for example, the risk of market-based governance approaches crowding out other (policy) alternatives (Bailey et al., 2011; Bailey & Wilson, 2009).

Much of the research on carbon markets and the carbon economy has focused on the "downstream, post-utility end of economic activity" (Bridge, 2010, p. 822), that is, exploring governance structures aimed at the prevention and sequestration of carbon *emissions*. Yet there is more to the carbon economy than solving downstream emission and sequestration problems. Indeed, the carbon economy reaches back upstream from the point of emissions to the extraction of fossil fuels (Bridge, 2010). Climate change mitigation measures that target the supply side of the carbon economy include material instruments that erect legal or physical barriers to fossil fuel supply chains as well as financial measures designed to curtail fossil fuel production (Le Billon & Kristoffersen, 2019).

An example of the latter is the fossil fuel divestment movement, which seeks to pressure asset owners into divesting from fossil fuel companies (Hunt, Weber, & Dordi, 2017). In recent years, economic geographers have shed light on the effects of divestment movements, documenting, for example, that national divestment campaigns reduce new capital flows to domestic oil and gas companies (Cojoianu, Ascui, Clark, Hoepner, & Wójcik, 2021).

While research in economic geography has generated important insights into the constitution, governance, and effects of the carbon economy (Boyd et al., 2011), companies as key economic actors have not been a significant focus in extant research. This is not to suggest that the role of private organisations in the carbon economy has been ignored. For example, prior studies highlighted the importance of consultancies, law firms, accountants, auditors, brokers, and other private organisations in creating the institutions and infrastructure that constitute carbon markets (Bumpus & Liverman, 2008; Knox-Hayes, 2010). But companies tend to feature implicitly rather than explicitly in these studies, with their significance and agency often relegated to abstract aggregates (e.g. the firms, the banks, etc). This reflects the limited attention that companies have received in economic geography at large (Maskell, 2001; Taylor & Asheim, 2001; Yeung, 2005), with extant research largely focused on questions of firms' location choices and the resulting spatial distribution of corporate activities in geographical clusters (Beugelsdijk, McCann, & Mudambi, 2010; Delgado, 2018). Despite recent efforts to engage more explicitly with organisation, management, and strategy studies (Jones, 2016; Knight, Kumar, Wójcik, & O'Neill, 2020; Knight & Wójcik, 2017), the firm rarely takes centre stage (see Schoenberger, 1997 for an exception) and "economic geographers usually fail to spell out how firms identify ends and develop and employ means that enable them to meet the ends" (Maskell, 2001, p. 329).

An exception is the work on global production networks (GPN), where companies feature as key actors involved in organising the "interconnected functions, operations and transactions through which a specific product or service is produced, distributed and consumed" (Coe, Dicken, & Hess, 2008, p. 272). Responding to the challenge of analysing globalised economic processes with state-centric analytical approaches, the GPN perspective emerged in the 2000s as an alternative conceptual framework for examining how firm actors and non-firm actors (e.g. states, international organisations, consumers, civil society and labour organisations) create economic value through intra-, inter-, and extra-firm relations that operate across multiple geographical and organisational scales (Coe et al., 2008; Coe, Hess, Yeung, Dicken, & Henderson, 2004; Henderson, Dicken, Hess, Coe, & Yeung, 2002; Hess & Yeung, 2006; Yeung, 2018).

Although the GPN framework does not provide a dedicated theory of the firm, companies are viewed as heterogeneous actors that are central to the constitution and coordination of GPNs (Yeung, 2018). More recently, conceptual efforts have sought to enhance the theoretical purchase of the GPN framework by developing causal explanations of the origins and dynamics of GPNs (Coe & Yeung, 2015). These attempts to develop a GPN 2.0 framework grant companies even more analytical currency and identify a set of firm-level strategies to explain particular configurations of GPNs (Yeung & Coe, 2015), thus highlighting the agency of firms to shape these networks (Coe & Yeung, 2019; Fuller & Phelps, 2018). Although prior research has explored the intersection between GPNs and the natural environment (e.g. Bridge, 2008b; Werner, 2021), this literature has little to say about the role of companies and GPNs in driving, mitigating, and adapting to climate change.

Returning to research on the carbon economy – the body of work most concerned with climate change in the field of economic geography – only few studies adopt an organisational lens to explore how companies navigate and shape societal efforts to mitigate climate change. Ormond (2015) explores how retail companies introduced new consumption-based frames of visibility around carbon emissions by calculating carbon emissions at the product level. Based on interviews with stakeholders involved in these product carbon footprinting practices, the study shows how retailers leveraged their powerful positions to enrol other actors across supply chains in measuring, monitoring, and ultimately reducing their contribution to a product's carbon footprint. In doing so, retail companies established a "regime of responsibilization" that allowed them to recast themselves as part of the solution – rather than the problem – to the climate crisis (Ormond, 2015). The tendency to outsource the responsibility for carbon emissions is also documented by Walenta (2018), who found that large U.S. companies reduced carbon emissions under their immediate control by 3% and increased emissions residing in their value chain by 5% between 2010 and 2015. The finding that companies strategically allocate carbon emissions in their value chains is further supported by Ben-David et al.'s (2021) large sample evidence that multinational companies headquartered in countries with strict environmental policies concentrate their most carbon emission intensive operations in countries with relatively more lenient policies.

Overall, however, insights into the role of companies in the carbon economy are limited within economic geography. While economic geographers have made important contributions to understanding the emergence and functioning of market-based governance approaches to the climate crisis, companies have been mostly treated as a black box and their inner workings, strategies, and impacts have received little attention. This is somewhat surprising since much of the carbon economy research is concerned with examining – often critically – the involvement of private actors in carbon markets and other climate change mitigation efforts (Bumpus & Liverman, 2008; Prudham, 2009). This thesis argues that putting a greater focus on corporate activities in economic geography research on climate change is important for several reasons.

1. *Economic significance*: companies are key actors in economic processes and, in the case of large multinational corporations, represent a substantial segment of the global economy (Dunning & Lundan, 2008; Iammarino & McCann, 2013). For instance, OECD estimates indicate that the activities of multinational corporations accounted for one third of global production and almost one third of world GDP in 2014 (OECD, 2018). Reducing carbon emissions from economic activities – whether through market-based or other governance approaches – thus invariably implicates corporate activities, making companies key sites for climate change mitigation research (Newell, 2020). With the impacts of a rapidly changing climate manifesting ever more clearly (e.g. through increased frequency of extreme weather events), the role of companies in supporting or potentially hindering effective climate change adaptation emerges as another important research question (Averchenkova et al., 2016).
2. *Political significance*: With economic might comes political power and the ways in which companies use this power is an important factor shaping climate change mitigation and adaptation. As reviewed above, economic geographers have explored the role of private organisations in market-based governance arrangements (e.g. carbon markets), but few studies illuminate the political significance of companies from an organisational perspective (e.g. Ormond, 2015).
3. *Environmental significance*: Closely linked to their economic and political significance, corporate activities also have substantial environmental impacts. The vast majority of anthropogenic carbon emissions is linked with the use of energy in various economic activities (e.g. electricity generation, industrial manufacturing, transport) and these activities are typically organised, controlled, and executed by

> companies. For example, nearly two thirds of all cumulative carbon and methane emissions between 1751 and 2010 can be traced back to just 90 oil, gas, coal, and cement producers (Heede, 2014). The emissions from these producers account for approximately 57% of the observed rise in atmospheric $CO_2$ and 42–50% of the rise in global mean surface temperature over this historical period (Ekwurzel et al., 2017). Importantly, 81 out of the 90 producers are companies (50 investor-owned, 31 state-owned) that extract, process, and market fossil fuels to customers (typically other companies) across the world (Heede, 2014). This highlights the significance of companies – both as producers and consumers of fossil fuels and derivative products – driving climate change. When it comes to climate change mitigation, what companies are doing (products and services) and how they are doing it (operations) matters.

Given the economic, political, and environmental significance of companies, this thesis proposes that it's important to add companies as a key unit of analysis to economic geography research on climate change. In doing so, it is critical to move beyond the conception of the firm as merely a "formative element in an economic system" that is captured abstractly by "crude categorizations" such as a multinational or a family firm (Taylor & Asheim, 2001, p. 315). There is no abstract, representative company that mechanically responds to market forces or climate governance structures such as carbon markets. To illustrate this point, it is helpful to distinguish between climate-forcing assets[10] that accelerate climate change and climate-saving assets that facilitate the decarbonisation of the economy (Colgan et al., 2021; Paterson, 2021). Companies differ in the ratio of climate-forcing and climate-saving assets that they control, and the different asset structures have

[10] Following Colgan et al. (2021), assets are understood to be „a broad category that includes all inputs to production and sources of material wealth: capital, labor, and natural endowments." (Colgan, Green, & Hale, 2021, p. 586).

important implications for how companies act on climate change (see Chapter 4). Consider the fictious example of utility company A operating a fleet of coal power plants and utility company B operating wind and solar power parks – these two companies are likely to have substantially different positions on climate change mitigation and adaptation, even though they operate in the same sector and, possibly, the same geography. The purpose of this thesis is to open the organisational black box and explore the variation among corporate action on climate change more closely. To do so, the following section of the literature review draws on organisation studies to conceptualise companies as key economic actors that are spatially and temporally embedded in nature and society.

## 2.2 Organisational Perspectives on Climate Change

Organisations are a ubiquitous feature of modern life in industrialised societies. Influencing nearly every aspect of our life – including education, work, culture, health care, transport, security and a myriad of other activities – organisations are referred to as the "building blocks of our societies, and a basic vehicle for collective action" (Baum & Rowley, 2002, p. 1). Indeed, the Nobel Laureate Herbert A. Simon proposed that the term "organizational economy" would be more appropriate than the commonly used term "market economy" (Simon, 1991, p. 28) considering the ubiquity of organisations in economic interactions. Organisations already formed part of ancient civilizations, but their emergence as a dominant social phenomenon began only in the $17^{th}$ to $18^{th}$ century (Scott & Davis, 2016) and – fuelled by the proliferation of education, task specialisation, and technologies – accelerated from 1850 onwards (Starbuck, 2005).

The systematic study of organisations and its formation as a distinct field of social inquiry is even more nascent, with the appearance of scientific writings about organisations commonly attributed to the 1940s. While some of the early work was rooted in sociology (e.g. Max Weber's analysis of bureaucracy), research on organisations has drawn ideas from multiple academic disciplines, including economics, sociology, psychology, anthropology, and biology (Baum & Rowley, 2002). Reflecting this multidisciplinary heritage, organisation research has evolved into highly diverse and somewhat fragmented field of study[11] that comprises different epistemological paradigms, disciplinary traditions, and levels of analysis (Tsoukas & Knudsen, 2005). While the different strands of organisation studies share a commitment to examining organisational phenomena, the considerable diversity in the field makes it difficult to formulate a unified formal definition of organisations (Baum & Rowley, 2002). However, there are three definitions that are commonly referenced for capturing the range of conceptual perspectives on organisations that occurred in organisation studies over the course of the twentieth century (listed in order of historical appearance in Table 2.1 below). It is important to note that the three perspectives represent different "schools of thought" – rather than coherent models of organisational structures – that are characterised by partial commonalities as well as substantial differences among each other (Scott & Davis, 2016).

**Table 2.1: Definitions of Organisations**

| Organisations as… | Definition |
|---|---|
| Rational systems | "organizations are collectivities oriented to the pursuit of relatively specific goals and exhibiting relatively highly formalized social structures." (Scott & Davis, 2016, p. 29) |
| Natural systems | "organizations are collectivities whose participants are pursuing multiple interests, both disparate and common, but who recognize the value of perpetuating the organization as an important resource." (Scott & Davis, 2016, p. 30) |
| Open systems | "organizations are congeries of interdependent flows and activities linking shifting coalitions of participants embedded in wider material-resource and institutional environments." (Scott & Davis, 2016, p. 32) |

[11] The heterogeneity of the field is also reflected in the variety of terms that are used (often interchangeably) to refer to it, including organisation science (Baum & Rowley, 2002), organisation theory (Tsoukas & Knudsen, 2005), and organisation studies (Nord, Lawrence, Hardy, & Clegg, 2006). This thesis follows Clegg et al. (Clegg, Hardy, Lawrence, & Nord, 2006) and uses the term organisation studies to the heterogeneous and overlapping conversations that constitute the field of study.

The conceptual fragmentation – combined with the field's multidisciplinary heritage – might explain why organisation studies have struggled since its inception to clearly articulate how its central object of study – organisations – are different from other social forms. Despite the explicit focus on studying all things organisational, the "ontological status of the organization as a distinct kind of social entity is not well theorized" (King, Felin, & Whetten, 2010, p. 291). This conceptual neglect of organisations as the central entity in organisation studies is partly a product of the rise of open systems perspective in the 1980s, which shifted the focus decisively towards structural inquiries of the social contexts in which organisations operate (Hirsch & Lounsbury, 1997). As a result, the "organizations field as a whole has become decidedly less organizational in its focus" (Gavetti, Levinthal, & Ocasio, 2007, p. 524). To counter this ironic absence of the organisation as the key object of study, King et al. (2010) proposed a meta-theory of organisations as social actors that are distinct from other collective structures such as markets and communities. This meta-theoretical work is important for the purpose of this thesis, since studying corporate action on climate change presupposes implicitly that companies are actors capable of undertaking intentional actions.

*Organisations as social actors*

According to King et al. (2010), the organisational actor concept is underpinned by two assumptions. First, the external attribution assumption refers to the idea that society attributes the capacity to act to organisations. On the one hand, organisations have sovereignty in their decision-making that is granted by external stakeholders. In the case of the modern corporation, the state grants formal authority to organisations to select its members and exert certain controls over their behaviours. Hence, "the organization exercises power in deliberately admitting and dismissing members of the organization and in 'controlling' behavior through rules, rewards, and sanctions." (King et al., 2010, p. 293). On the other hand, organisations also have responsibility for actions and external stakeholders hold organisations accountable through legal and reputational sanctions (King et al., 2010).

Second, the intentionality assumption posits that "organizations have intentions that are partially independent from the beliefs, values, preferences, and goals of their constituents" (King et al., 2010, p. 294). The intentionality of an organisation is rooted in its identity, which is composed of the central and distinctive organisational features that define an organisation and distinguish it from others. By representing the essence of what an organisation is, identity stabilises expectations of members and outsiders and "makes possible coherent, predictable social interaction within and among organization" (King et al., 2010, p. 295). Moreover, organisational intentionality is also expressed through organisational goals that direct the behaviour of organisational members and serve as a benchmark for evaluating strategies, behaviours, and outcomes (King et al., 2010).

Together, the external attribution and intentionality assumptions form the basis of conceptualising organisations as social actors that are more than just a collection of individuals or mere products of particular social contexts. Instead, organisations are viewed as distinct social actors capable of purposeful, intentional action – including action on climate change. For the purpose of this thesis, the meta-theory described above is useful for two reasons. First, it is helpful for conceptually clarifying the key unit of analysis in this thesis. Importantly, the meta-theoretical conceptualisation of organisations as social actors is broad enough to accommodate the different perspectives and disciplinary discourses in each of the subsequent empirical chapters. Second, it highlights the capability of organisations to intentionally respond to and act on their environments. Together, the meta-theoretical view of organisations as social actors serves as the conceptual backbone for examining corporate action on climate change in this thesis.

*Denatured view of organisational environments*

While companies have been treated as an "'undersocialized' analytical category in much economic geography" (Yeung, 2005, p. 309), the majority of organisation and management (O&M) research has worked with what might be called an oversocialized view of companies that is largely void of material, biological, or physical considerations (Shrivastava, 1995a). Despite the vast accumulation of scientific evidence that anthropogenic carbon emissions are responsible for the increase of the global mean surface temperature (IPCC, 2014a, IPCC, 2018) and the prominence that the issue of climate change has gained in public discourse, there has been little cross-over between natural sciences and O&M research. Although research on environmental (and social) dimensions of business activities has grown into a vibrant field of corporate sustainability research (Bansal & Song, 2017), "management scholars have yet to adequately link business processes to macro ecological processes and boundary conditions" (Whiteman et al., 2013, p. 308). Despite efforts to explicitly conceptualise and analyse the interplay between organisation-level firm activities and system-level processes in the natural environment (Gladwin, Kennelly, & Krause, 1995; Purser, Park, & Montuori, 1995; Shrivastava, 1995b; Winn & Pogutz, 2013), much of O&M research continues to work with a largely "denatured view" of organisational environments (Shrivastava, 1995a, p. 125) that is dominated by social factors and from which biophysical processes are conspicuously absent (Bansal & Knox-Hayes, 2013; Whiteman et al., 2013).

System perspectives on business sustainability aim to overcome the ecological illiteracy of O&M studies by drawing on systems thinking to conceptualise companies as entities that are spatially and temporally embedded in both social and ecological systems[12]

[12] The terms ecosystem and ecological system are used interchangeably here and the definition put forward by the Millennium Ecosystem Assessment (2005, v) is adopted: "An ecosystem is a dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit".

(Bansal & Song, 2017; Marcus, Kurucz, & Colbert, 2010; Starik & Kanashiro, 2013; Williams, Philipp, Kennedy, & Whiteman, 2017). Rooted in systems and complexity theory (Levy & Lichtenstein, 2012), systems thinking is centred on "the ability to see the world as a complex system, in which we understand that 'you can't do just one thing' and that 'everything is connected to everything else'" (Sterman, 2001, pp. 9–10). Applied to the interactions between business organisations and the natural environment, a systems perspective explicitly recognises the impact and dependency of firms on the functioning of ecological processes (Winn & Pogutz, 2013). Organisations are thus conceptualised as ecological agents with material biophysical footprints whose activities both contribute to and are affected by climate change.

In the context of climate change, the dual relationship of impact and dependency between firms and the Earth's climate system can be captured under the themes of climate change mitigation and climate change adaptation. On the one hand, business activities are major sources of carbon emissions and, therefore, constitute one of the main drivers of changing climate patterns and global warming. For instance, approximately 57% of the observed rise in atmospheric $CO_2$ and between 42-50% of the rise in global mean surface temperature between 1880 and 2010 can be attributed to 90 firms operating in the oil and gas, coal, and cement sectors (Ekwurzel et al., 2017; Heede, 2014). Hence the mitigation of future climate change and global warming requires businesses to drastically reduce carbon emissions (Millar et al., 2016). On the other hand, companies are also exposed to the biophysical consequences of climate change (Averchenkova et al., 2016; Linnenluecke et al., 2013). For example, the increased frequency and severity of extreme weather events, such as heat waves, droughts, or flooding, pose major challenges for maintaining business operations in affected areas (McKinsey Global Institute, 2020).

Although O&M studies have recently started paying greater attention to the role of companies in addressing climate change (e.g. Chandy et al., 2019; Howard-Grenville, Buckle, Hoskins, & George, 2014; Wittneben, Okereke, Banerjee, & Levy, 2012), the engagement has largely been confined within the social scientific paradigms dominating the field with limited appreciation of the physical materiality of climate change (Bansal & Knox-Hayes, 2013). This is where (economic) geography with its hybrid position between social and natural sciences could enter a fruitful exchange with organisation studies on climate change. The analytical sensitivity of economic geographers to space and time can provide a valuable lens for examining companies at the interface between human and natural environments (Bansal & Knox-Hayes, 2013; Whiteman et al., 2013), as "[p]lace, after all, represents the coalface, the grounded intersection of business activities, nature, and society." (Shrivastava & Kennelly, 2013, p. 86). This thesis thus draws on economic geography and organisation studies to conceptualise companies as both social and ecological actors that are spatially and temporally embedded in nature and society.

## 2.3 The Role of Accounting in Corporate Action on Climate Change

In addition to economic geography and organisation studies, this thesis also leverages accounting research to examine corporate action on climate change. Accounting is commonly viewed as a primarily technical exercise of measuring, processing, and communicating (financial) information and it is this technical perspective that has dominated much of accounting research during the twentieth century (Hopwood, 2007). However, this technical view of accounting is reductive and ignores the significance of seemingly mundane calculative practices in shaping the social and economic relations that constitute societies. The forebearers of the social sciences as we know them today were acutely aware of the social significance of accounting (Burchell, Clubb, Hopwood, Hughes, & Nahapiet, 1980), with Max Weber identifying calculation as the central mechanism of economic rationalisation and the concurrent rise of capitalistic enterprises (Chapman, Cooper, & Miller, 2009). Following the prominent role of accounting in social scientific inquiries in the early twentieth century, the social implications of accounting subsequently vanished from research agendas for almost half a century, until re-emerging in the 1980s as a distinct strand of accounting research that understood accounting as a constitutive element of organisational and social practice (e.g. Burchell et al., 1980; Burchell, Clubb, & Hopwood, 1985). This shift towards a decidedly socological perspective on accounting was catalysed by the work of Anthony Hopwood, founder of the journal *Accounting, Organizations and Society*, and is characterised by the understanding that "[o]rganizations and accounting practices within them, are intrinsically dynamic and social entities" (Miller, 1994, p. 6).

From this perspective, accounting plays a central role in constructing organisations as social actors (Bromley & Sharkey, 2017) by providing the calculative practices that allow actors to describe and act on entities, processes, and individuals (Chapman et al., 2009). Instead of a merely technical instrument, accounting is conceptualised as a fundamentally social practice that defines organisational boundaries and determines what is rendered thinkable, visible and, ultimately, actionable in economic organizations (Hines, 1988; Llewellyn, 1994; Miller & Power, 2013). The characteristics of organisational actors – sovereignty, responsibility, identity and goals (King et al., 2010) – are shaped by and manifest in organisational processes that are facilitated by accounting practices. For example, the ability to control behaviour within organisations is a defining feature of the sovereignty of organisational actors and accounting is the calculative infrastructure through which this control is exercised (Macintosh & Quattrone, 2010; Malmi & Brown, 2008), for instance in the form of performance measurement systems (Ferreira & Otley, 2009). By representing and performing the material manifestation of organisational processes, accounting practices weave the organisational fabric that constitutes firms as social actors:

> "If organizing without accounting is increasingly unthinkable today, accounting also makes organizing thinkable and actionable in a particular way. For example, while management or regulators may be concerned with issues of efficiency or value for money, it is accounting practices that enable such ideas to be operationalized and made real. In making visible and calculable the objects and activities that are at the heart of management, accounting creates a facticity that appears objective and unchallengeable, beyond the fray of politics or mere opinion." (Miller & Power, 2013, pp. 558–559)

It is the facticity engendered by accounting – and the seemingly unchallengeable objectivity it lends to technocratic governance approaches – that has attracted considerable attention in economic geography studies of the carbon economy (Boyd et al., 2011; Boykoff et al., 2009). Accounting is an essential component in the creation and operation of carbon markets as it provides the calculative infrastructure that enables the commodification of carbon emissions as fungible assets that can be traded in carbon markets (Lohmann, 2009; Lovell & MacKenzie, 2011; MacKenzie, 2009). This thesis shares this interest in examining accounting as a way of making climate change mitigation actionable, but it is focused on exploring how the use of calculative practices mediates action on climate change in business organisations. To this end, the thesis engages with two complementary bodies of accounting studies. One the one hand, it draws on managerial accounting research that is concerned with the use of calculative practices for internal purposes, such as budgeting, investment appraisals, or performance measurement systems. On the other hand, the thesis leverages financial accounting research that is concerned with the production of financial – and increasingly also non-financial – accounts for external audiences (e.g. capital market participants).

## 2.4 Summary

The purpose of this thesis is to examine corporate action on climate change. Spanning social and natural sciences, (economic) geography is principally well suited to examining the human-environment relations at the heart of the climate crisis. Although economic geographers have generated valuable insights into market-based governance approaches to climate change, companies have been mostly treated as a black box and their role in driving, mitigating, and adapting to climate change has received limited attention in economic geography. This reflects the vague status of firms in much of the economic geography literature, which has paid limited attention to companies and their economic, political, and environmental significance.

The thesis thus turns towards organisation and management (O&M) studies to conceptualise companies as socio-ecological actors that are spatially and temporally embedded in nature and society. This perspective establishes companies as actors operating at the interface of human and natural environments and serves as the conceptual backbone for examining corporate action on climate change. To open the organisational black box and allow a closer investigation of companies' inner workings, this thesis also leverages insights from accounting research into the organisational and social roles of calculative practices. Rather than a merely technical exercise, accounting is viewed as a fundamentally social practice that is constitutive of organisations and allows companies to describe and act on climate change.

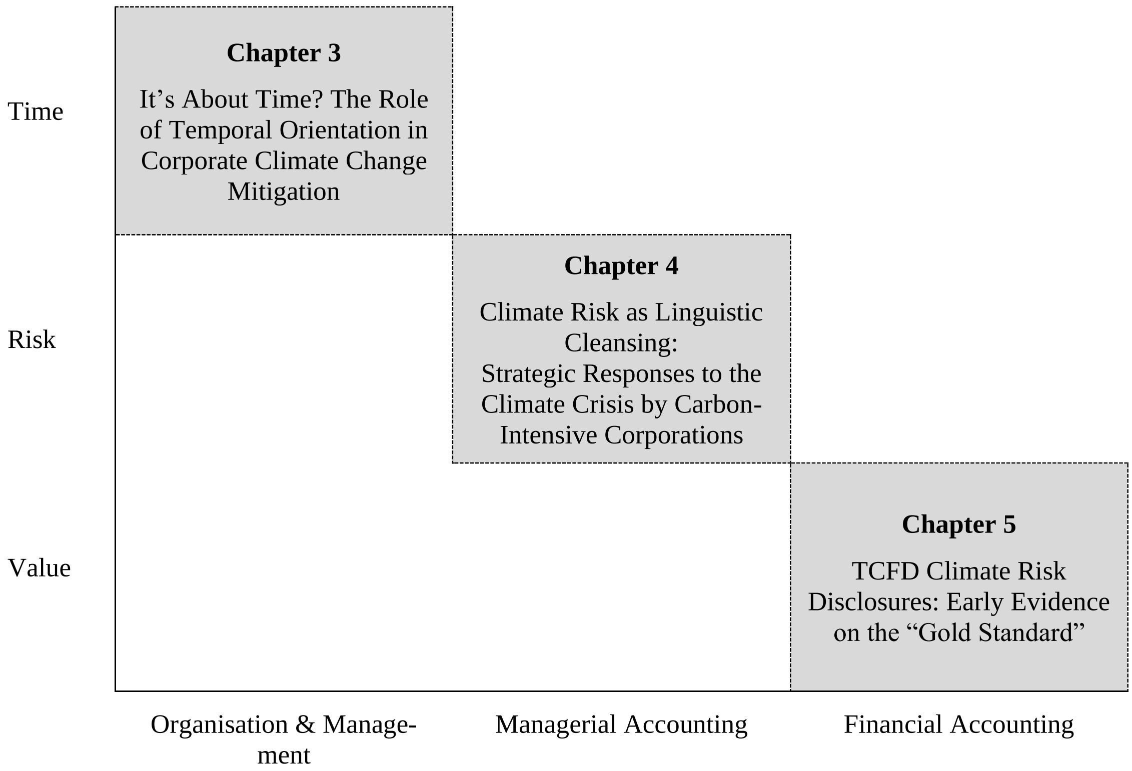
The literature review at hand establishes the role of companies in driving, mitigating, and adapting to climate change as a multidisciplinary object of study and serves as a backdrop to the in-depth discussions included in the subsequent chapters. Drawing on O&M, managerial accounting, and financial accounting studies, each of these chapters uses field-specific theoretical resources, methodologies, and discourses to examine corporate action on climate change from a particular perspective (see Figure 2.1 below).

Chapter 3 approaches the question how companies act on climate change through the prism of time and investigates the relationship between organisational time orientation and corporate climate action. Grounded in the organisation and (strategic) management literature, this chapter explores whether long-term oriented companies are more likely to take effective climate action that results in lower corporate carbon emissions.

Chapter 4 uses the notion of risk as an analytical lens to explore corporate action on climate change. With a focus on examining how calculative practices are implicated in shaping corporate understandings of and strategic response to climate change, this chapter is situated in the field of managerial accounting studies.

Chapter 5 investigates corporate action on climate change from the perspective of the third theme of this thesis – value. Based on insights from the financial accounting literature into the determinants and capital market implication of voluntary disclosures, this chapter investigates how the voluntary disclosure of climate risk exposure is reflected in the stock market values of publicly listed companies.

**Figure 2.1: Logic of Chapters 3, 4 and 5**



# 3 It’s About Time? The Role of Temporal Orientation in Corporate Climate Change Mitigation

## 3.1 Introduction

The world is on track to reach 3 °C of warming above pre-industrial levels by the end of the century (Climate Action Tracker, 2019) and there is a significant risk that such temperature increases trigger severe environmental changes with catastrophic impacts on natural and human systems (IPCC, 2014a). In fact, human-induced climate change is already affecting weather and climate extremes across the globe, manifesting in the increased frequency and severity of heatwaves, droughts, tropical cyclones and other extreme weather events (IPCC, 2021). To limit further global warming and mitigate severe climate impacts, global anthropogenic carbon emissions need to reach net zero around 2050 (IPCC, 2018). This means that companies, and societies at large, need to take rapid action that minimises the impact of corporate activities on climate change by reducing, and ultimately, eliminating the release of carbon dioxide into the atmosphere (Millar et al., 2016). Evaluated against this benchmark, corporate climate action is only effective if it delivers durable emission reductions that result in lower corporate carbon emissions (Dahlmann et al., 2017; Slawinski et al., 2017). And while climate change has become an increasingly prominent issue on corporate agendas, [13] there are few signs that companies have significantly reduced carbon emissions (CDP, 2015; Dietz et al., 2021; Doda et al., 2016) and emissions on a global level have continued to rise largely unabated over the last decade (Peters et al., 2020).

[13] For example, 6937 companies provided information on how they manage their climate change impacts in 2018 (CDP, 2019b) and more than 1000 companies declared their support for the Task Force on Climate-related Financial Disclosure (TCFD) as of February 2020. Established by the Financial Stability Board, an international body comprised of national banks and finance ministries, in December 2015, the TCFD has developed recommendations for companies around the disclosure of climate-related financial impacts (TCFD, 2017b).

The urgent need for drastic emission reductions stands in stark contrast to the slow uptake of effective climate action by companies, highlighting the importance of exploring the role of time in corporate climate change mitigation. Prior organisation and management (O&M) research has identified organisational time perspectives as an important factor shaping corporate action on climate change (Sarasini & Jacob, 2014; Slawinski et al., 2017; Slawinski & Bansal, 2012, 2015). For example, Slawinski and Bansal (2012) found that the strategic responses of Canadian oil and gas companies to climate change differed according to their respective time perspectives being either *linear* or *cyclical*. The former comprised a low tolerance for uncertainty, a focus on the present, and short planning horizons, whereas the latter was characterised by a higher tolerance for uncertainty, awareness of past actions, and long planning horizons (Slawinski & Bansal, 2012). Building on these insights, Slawinski et al. (2017) developed a multi-level framework that proposes two mechanisms – short-termism and uncertainty avoidance – to explain organisational inaction on climate change. The conceptual framework delineates how time perspectives operate on individual, organisational, and institutional levels, arguing that short-term oriented companies are less likely to engage in effective climate action, that is, undertake measures that achieve durable carbon emission reductions and result in lower corporate carbon emissions. It is unclear, however, whether this postulated relationship between time perspectives and carbon emissions holds true empirically.

The purpose of this study is to address this gap by examining the relationship between organisational time orientation – defined as the importance that organisations attribute to the past, present and future (Bluedorn, 2002) – and corporate carbon emissions. Climate change mitigation requires corporate investments to reduce, and eventually eliminate, carbon emissions. Hence, companies need to incur costs in the present to gain (uncertain) benefits of decarbonised business models in the future. Drawing on organisational literature on time orientation (Laverty, 1996, 2004; Marginson & McAulay, 2008; Reilly et al., 2016), I follow Slawinski et al. (2017) and argue that the propensity to make these investments is associated with companies' organisational time orientation. More specifically, I hypothesise that companies with a long-term orientation are more likely to invest in decarbonisation measures, which is reflected in lower corporate carbon emissions.

To test this proposition, I operationalise organisational time orientation on three dimensions. First, I utilise a psycholinguistic approach to measure the temporal focus of CEOs based on speech extracted from earning conference calls with investors. Second, the time orientation of executive compensation is analysed by measuring whether compensation structures include forward-looking targets and sustainability factors. Third, I measure the time orientation of ownership structures by categorising shareholders according to their temporal preferences inferred from past trading behaviour. Estimating a fixed effects regression model of the relationship between organisational time orientation and corporate carbon emissions, the results support the hypotheses that long-term oriented CEOs and long-term oriented shareholders are negatively associated with corporate carbon emissions, whereas the inclusion of sustainability factors into executive compensation is positively related to carbon emissions. The inclusion of forward-looking targets into executive remuneration packages has no statistically significant effect on corporate carbon emissions. While the finding that companies with long-term oriented CEOs and shareholders have lower carbon emissions is consistent with the formulated hypotheses, the positive – instead of negative – relationship between sustainability incentives and carbon emissions is surprising. This finding might reflect a more symbolic rather than substantive use of sustainability-linked incentives (Bowen, 2014), with companies integrating sustainability criteria into executive compensation to signal a superficial environmental commitment (Berrone & Gomez-Mejia, 2009).

This study on the relationship between organisational time orientation and corporate carbon emissions is important for at least three reasons First, I provide empirical support for the notion that long-term oriented companies are more likely to take effective climate action and generate less carbon emissions (Slawinski et al., 2017). Second, the study responds to calls for organisation and management (O&M) research to take planetary boundaries seriously and pay close attention to the consequences of business activities for the natural environment (Bansal & Knox-Hayes, 2013; Whiteman et al., 2013; Winn & Pogutz, 2013). By examining the relationship between organisational time orientation and corporate carbon emissions, this study puts the biophysical impacts of companies on climate change at the heart of the analysis and adds new empirical insights to extant research on the influence of organisational features on corporate carbon emissions (Dahlmann et al., 2017; Ioannou et al., 2016). Third, I contribute to the growing literature on the role of time in organisations and strategic management (e.g. Chen & Nadkarni, 2017; Nadkarni & Chen, 2014; Nadkarni, Chen, & Chen, 2016). Much of this research has been focused on examining companies in a North American setting (DesJardine & Bansal, 2019; Flammer & Bansal, 2017; Gamache & McNamara, 2019; Souder & Bromiley, 2012; Zhang & Gimeno, 2016), but perceptions and experiences of time differ between cultural settings (Bluedorn, 2002). With the empirical focus on examining the time-climate action nexus in European firms, this study contributes insights from a different cultural context to the extant literature.

The remainder of this study is structured as follows: Section 3.2 provides theoretical perspectives on the temporality of climate change (Section 3.2.1), organisational time orientation (Section 3.2.2), and the relationship between organisational time orientation and corporate climate action (Section 3.2.3). Section 3.3 outlines the methodology and Section 3.4 presents the results. Section 3.5 discusses the theoretical and practical implications of the findings and reflects on the study's limitations and future research directions.

## 3.2 Theoretical Perspective

### 3.2.1 Temporality of Climate Change

The term *climate change* refers to changes in weather patterns over decades, centuries, and millennia (Pittock, 2010). What we know about climate change is derived from geological climate records (e.g. ice cores retrieved from Antarctica) that go back tens and hundreds of thousand years (Caseldine, 2012; Emanuel, 2016). These paleoclimatic insights into the Earth's climate system provide the building blocks for modelling future climate change scenarios (e.g. IPCC, 2018). Beyond the temporal aspects of knowledge production about climate change, the scientific, political, and economic discourses around climate change are also steeped in temporality, invoking notions of the future, time lags, speed, urgency, and deadlines. Pahl et al. (2014) identify two fundamental temporal dimensions of climate change as a biophysical phenomenon, which are particularly consequential for human response mechanisms to it. First, climate change extends into the future, that is, many of the most significant impacts of climate change will materialise over decades and centuries (van Renssen, 2019). Second, and closely related to the first dimension, the relationship between causes and effects of climate change is characterised by time lags. For example, a substantial fraction of emitted carbon dioxide ($CO_2$) remains in the atmosphere for centuries, locking in corresponding mean surface temperature levels over this time span (Knutti & Rogelj, 2015). So even if temperature levels were stabilised through the abrupt elimination of carbon emissions, the effects of any warming above pre-industrial levels, such as the melting of large ice sheets, would continue for generations.

The temporal dimensions of the biophysical processes driving climate change are implicated in the difficulties that societies experience in responding to the threats of global warming. Indeed, climate change has been described as a super wicked problem that is characterised by two temporal features, namely that "time is running out […] and irrational discounting occurs that pushes responses into the future" (Levin, Cashore, Bernstein, & Auld, 2012, p. 124). The urgency to address climate change through the reduction of carbon emissions is linked to the long half-life of $CO_2$ in the atmosphere and the fact that higher $CO_2$ concentrations in the atmosphere lock in higher temperature levels for centuries. Irrational discounting of the future refers to behaviours and strategies that prioritise a course of action in the short-term, even if there is strong evidence of the risks of serious detrimental impacts from this course of action in the long-term (Levin et al., 2012). Rooted in the time lag between the biophysical causes (carbon emissions in the present) and effects of climate change (e.g. melting of ice sheets in the future), this temporal asymmetry in human response mechanisms to climate change is further exacerbated by social structures that operate with relatively short time scales such as four-year election cycles (Pahl et al., 2014).

Mark Carney, former Governor of the Bank of England, aptly captured this mismatch between biophysical time scales of climate change and societal time horizons as the *Tragedy of the Horizon*, pointing out that "the catastrophic impacts of climate change will be felt beyond the traditional horizons of most actors – imposing a cost on future generations that the current generation has no direct incentive to fix" (Carney, 2015, p. 4). Mitigating climate change requires massive investments into decarbonising economic activities (Stern, 2011) and firms – in particular in carbon-intensive industries – are key actors for making these investments and realising carbon emission reductions. Consider, for example, the iron and steel industry: Relying on high-temperature heat in production processes, the iron and steel sector is currently largely fossil fuel based and accounts for 7% of global energy-related carbon emissions (Energy Transitions Commission, 2018a). While decarbonising steel production processes is technologically feasible, it requires large-scale investments into low-carbon technologies to achieve net zero emissions, that is, firms need to incur costs in the present (deploying finance, expertise, attention, etc.) to achieve an outcome in the future (net zero emissions). In other words, climate change poses a fundamental intertemporal choice problem for companies and society at large.

### 3.2.2 Organisational Time Orientation

Intertemporal choices are characterised by "decisions in which the timing of costs and benefits are spread out over time" (Loewenstein & Thaler, 1989, p. 181) and are common in social and organisational life. Indeed, balancing the distributions of costs and benefits over time is a fundamental problem of management and has been subject of extensive discussions in organisation & management (O&M) research (Laverty, 1996; Reilly et al., 2016). For instance, companies need to meet short-term objectives – such as delivering financial results that satisfy shareholder expectations – while simultaneously investing in capabilities – e.g. Research & Development – that enable them to maintain their long-term competitiveness (e.g. Laverty, 1996, 2004). How companies balance these intertemporal tensions is influenced by their temporal focus, which reflects the "allocation of attention to the past, present, and future" (Shipp, Edwards, & Lambert, 2009, p. 2). Derived from psychological insights into how individuals think about time (e.g. Zimbardo & Boyd, 1999), temporal focus constitutes an important aspect of individual and collective perceptions, experiences, and management of time (Bluedorn, 2002; Bluedorn & Denhardt, 1988). Following prior research on the role of temporal considerations in organisational decision-making (Laverty, 2004; Marginson & McAulay, 2008; Reilly et al., 2016), this study conceptualises temporal focus as a firm-level phenomenon that is shaped by individual temporal preferences of key decision-makers, organisational processes, and institutional dynamics (Slawinski et al., 2017). In this study, I refer to this firm-level temporal focus as *organisational time orientation* and define it as the importance that an organisation attributes to the past, present, and future (Bluedorn, 2002).

Confronted with situations characterised by intertemporal choices, companies with a predominantly short-term orientation prioritise "*decisions and outcomes that pursue a course of action that is best for the short term but suboptimal over the long run* [italic in original]" (Laverty, 1996, p. 826). For example, short-term oriented companies respond to earnings pressure from securities analysts by engaging in competitive practices that boost their short-term earnings but undermine their long-term competitiveness (Zhang & Gimeno, 2016). Empirical evidence suggest that short-termism is prevalent among companies, in particular in the US where 78% of surveyed executives indicated that they would sacrifice profitable long-term projects to avoid missing short-term earnings targets (Graham, Harvey, & Rajgopal, 2005). The consequences of short-term corporate behaviour, however, can not only compromise long-term organisational success, but it can also have broader societal implications, such as undermining the economic prosperity of nations (Hayes & Abernathy, 1980) or thwarting societal efforts to mitigate climate change (Levin et al., 2012; Ortiz-de-Mandojana, Bansal, & Aragón-Correa, 2019; Slawinski et al., 2017).

With climate change posing a fundamental intertemporal choice problem for companies and society at large, organisational time orientation is a critical variable that influences how companies perceive and respond to climate change (Sarasini & Jacob, 2014; Slawinski et al., 2017; Slawinski & Bansal, 2012, 2015). While the intertemporal tensions around climate change manifest themselves in a range of strategic issues – including strategic planning, stakeholder engagement, and industry collaborations (Slawinski & Bansal, 2015) – they are particularly salient in resource allocation processes (Reilly et al., 2016). The very idea of investments is an inherently temporal conception that entails incurring costs in the present in expectation of receiving benefits in the future. As such, organisational time orientation is a crucial factor in corporate investment decisions, since the importance that is attributed to the past, present, and future shapes how companies manage the distribution of costs and benefits over time (Souder & Bromiley, 2012; Souder & Shaver, 2010). Climate change mitigation requires corporate investments to reduce, and eventually eliminate, carbon emissions. Hence, companies need to incur costs in the present to gain (uncertain) benefits of decarbonised business models in the future. I thus argue that the propensity to make these investments is associated with companies' organisational time orientation.

### 3.2.3 Organisational Time Orientation and Corporate Carbon Emissions

In the previous two sections I argued (1) that climate change poses a fundamental inter-temporal choice problem for companies; and (2) that organisational time orientation is an important variable influencing how companies act on climate change, which in turn determines corporate carbon emissions. This section elaborates on this relationship, arguing that companies' long-term orientation is negatively associated with corporate carbon emissions. Companies have different strategic options at their disposal to reduce carbon emissions, which range from product and process improvements to technological innovations (Cadez & Czerny, 2016; Weinhofer & Hoffmann, 2010). For many companies, especially those in carbon-intensive industries, the implementation of these strategic options requires investments in new technologies or assets with long life-cycles (Cadez & Czerny, 2016). Given their greater present time focus, short-term oriented companies are less likely to invest in decarbonisation projects that require upfront investments with deferred and uncertain benefits (Slawinski et al., 2017). Companies with a long-term orientation are more likely to recognise the interdependency between their long-term private interests and a stable climate system (Slawinski & Bansal, 2015), thus increasing their propensity to invest in decarbonisation measures that achieve lower corporate carbon emissions. For example, Ortiz-de-Mandojana et al. (2019) found that greater long-term orientation in electric utilities companies was associated with higher percentages of electricity generation from renewable energy sources. I thus hypothesise that organisational long-term orientation is negatively associated with corporate carbon emissions.

Organisational time orientation is a multidimensional phenomenon shaped by individual, organisational, and institutional factors (Laverty, 1996). On the *individual level*, the perception of time is a psychological feature of personal and social experiences that influences human behaviour (Zimbardo & Boyd, 1999). Individuals differ in their perceptions of the past, present, and future and these differences manifest themselves in relatively stable psychological constructs, such as temporal depth ("the distance looked into past and future") and temporal focus ("the importance attached to the past, present, and future") (Bluedorn, 2002, pp. 141–142). In organisational contexts, these individual time perceptions influence strategic planning and decision-making (Das, 1987; Mosakowski & Earley, 2000). In addition to time orientation as an individual-level construct, the importance that is attributed to the past, present, and future is reflected in *organisational processes*, such as performance measurement systems, remuneration structures, and organisational norms and cultures (Flammer & Bansal, 2017; Laverty, 2004; Marginson & McAulay, 2008). Finally, *institutional factors* also influence organisational time orientation. In fact, much of the discussions around corporate short-termism have been centred on the influence of capital markets on companies' time orientations (Laverty, 1996; Porter, 1992). More specifically, corporate ownership structures – often classified according to shareholders' attributes such as investor types or trading activities (Johnson, Schnatterly, Johnson, & Chiu, 2010) – have been identified as an important determinant of organisational behaviour (Connelly, Hoskisson, Tihanyi, & Certo, 2010), including organisational time orientations (e.g. Brochet, Loumioti, & Serafeim, 2015; Bushee, 1998).

Aligned with this multi-dimensional conception of organisational time orientation, Slawinski et al. (2017) proposed a framework to explain why companies fail to reduce carbon emissions. The framework outlines how factors related to short-termism and uncertainty avoidance operate at three levels – individual, organisational, and institutional – and inhibit effective organisational action on climate change. Following the structure of this multi-dimensional framework, I subsequently hypothesise that a long-term orientation of CEOs, incentive structures, and shareholders is negatively associated with corporate carbon emissions.

*Individual Dimension: Temporal Focus of CEOs*

CEOs are the most powerful decision-makers in companies and their cognition and values shape strategic choices and organisational outcomes (Hambrick & Mason, 1984). The importance that CEOs attribute to the past, present, and future (temporal focus) constitutes a cognitive filter that influences their perception and interpretation of strategic issues (Gamache & McNamara, 2019; Nadkarni & Chen, 2014; Yadav, Prabhu, & Chandy, 2007). In the case of climate change, CEOs with a strong future focus are less susceptible to discount future impacts of climate change (Levin et al., 2012). A strong CEO future focus is well-suited to recognise that many of the biophysical impacts of climate change (e.g. increased frequency and severity of extreme weather events) will materialise over the coming decades, and, importantly, those future impacts will carry more weight for CEOs with a strong future focus. Similarly, the propensity of future-focused CEOs to imagine future events is conducive to identifying different pathways of how societies will respond to climate change. In short, climate change – both as a biophysical and a social phenomenon – is a salient strategic issue for CEOs with a strong future focus.

The temporal focus of CEOs is also implicated in the strategic choices that companies make in the face of climate change. Mitigating climate change impacts – whether in form of biophysical consequences of global warming or societal interventions to decarbonise economies – implies the reduction of corporate carbon emissions and, ultimately, the decarbonisation of business models (Millar et al., 2016). For many companies, especially those in carbon-intensive industries, these decarbonisation measures depend on investments with upfront costs and (uncertain) deferred benefits. Based on the perception of climate change as a salient strategic issue, companies led by future-focused CEOs place a higher value on the deferred benefits of decarbonisation and, consequently, are more likely to invest in measures that reduce carbon emissions (Ortiz-de-Mandojana et al., 2019). This is consistent with Slawinski and Bansal's (2012) finding that companies using scenario planning to explore future states of the world considered investments in climate change mitigation to be less risky than companies that were less future-focused. I thus hypothesise that companies led by future-focused CEOs are more likely to invest in decarbonisation measures and generate less carbon emissions.

> *Hypothesis 1:* The future focus of CEOs is negatively associated with corporate carbon emissions.

*Organisational Dimension: Time Orientation of Executive Compensation*

Organisational processes are another lever that influences organisational time orientation (Laverty, 1996, 2004; Marginson & McAulay, 2008) and I argue that the importance which organisations attribute to the past, present, and future is reflected and shaped by remuneration systems. More specifically, I propose that executive compensation influences organisational time orientation by incentivising key decision-makers to direct attention to short-, medium-, or long-term organisational outcomes, which, in turn, affects companies' propensity to take effective climate action.

According to agency theory (Jensen & Meckling, 1976), managers' (agents) interests tend to diverge from firm owners' (principals) interests[14] and executive compensation is

[14] Assuming that managers own less than 100% of a companies' stock (Jensen & Meckling, 1976).

commonly identified as an important mechanism to align principal-agent interests. Depending on the timing of pay-outs, the structure of executive compensation can either be short-term (annual salary, annual bonus) or long-term oriented (deferred bonus payments, stock options). Prior research has shown that the temporal design of executive compensation can influence strategic choices. For example, the adoption of long-term compensation schemes was found to be associated with significant increases in capital investments (Larcker, 1983) as well as higher levels of innovation, corporate social performance, and long-term operational performance (Flammer & Bansal, 2017).

By stretching pay-outs over longer time horizons, long-term oriented executive compensation directs managerial attention to organisational outcomes in the more distant future and increases the attractiveness of investments where benefits are expected to materialise in the long-term (Deckop, Merriman, & Gupta, 2006). Given that investments in climate change mitigation are characterised by such deferred cost-benefit structures, I expect that companies with long-term executive compensation schemes invest more in decarbonisation measures and emit less carbon (Berrone & Gomez-Mejia, 2009; Ortiz-de-Mandojana et al., 2019).

> *Hypothesis 2a:* The long-term orientation of executive compensation is negatively associated with corporate carbon emissions.

While executive compensation has long been based primarily on financial outcomes, companies have begun tying certain elements of executive compensation schemes to social and environmental outcomes (Hong, Li, & Minor, 2016). Since improved social and environmental outcomes typically result from longer-term investments, the inclusion of social and environmental criteria into executive remuneration schemes is “likely to shift managers' attention toward longer-term efforts, leading them to adopt a longer time horizon” (Flammer, Hong, & Minor, 2019, p. 1101). In an analysis of S&P 500 companies’ executive compensation practices, Flammer et al. (2019) confirmed that the integration of social and environmental criteria in executive compensation was positively related to organisational long-term orientation and toxic emission reductions. I thus hypothesise that companies with sustainability-related incentives structures are more likely to invest into emission reduction measures and, as a result, emit less carbon.

> *Hypothesis 2b:* The integration of sustainability criteria into executive compensation is negatively associated with corporate carbon emissions.

*Institutional Dimension: Time Orientation of Ownership Structure*

Finally, the institutional context is an important influence on organisational time orientation and companies' propensity to take effective climate action (Slawinski et al., 2017). Capital market expectations are a particularly salient factor shaping the importance that companies attribute to the past, present, and future (Laverty, 1996). Depending on the specific ownership structure of companies, the exposure to institutional pressures from capital markets differs between companies (Connelly, Hoskisson et al., 2010; Johnson et al., 2010). This includes, among other factors, shareholders' expectations to receive financial returns in the short-, medium-, or long-term. Hence, I hypothesise that the temporal preferences of shareholders are another antecedent of organisational time orientation that influences how companies take climate action.

Investors allocate resources to companies and, after investing, monitor firm performance. If investors are dissatisfied with firm performance, they can either divest or pressure management to make strategic changes (Hoskisson, Hitt, Johnson, & Grossman, 2002). Depending on temporal preferences and investment horizons, investors exhibit different attitudes towards monitoring and engaging companies on strategic choices (Johnson et al., 2010). Long-term oriented investors tend to be supportive of corporate strategies that enhance the competitiveness of companies, even if those strategies have longer payoff periods. For example, the share of long-term oriented shareholders was found to be positively associated with corporate investments in Research & Development (Bushee, 1998; Hoskisson et al., 2002). By issuing public announcements, filing shareholder resolutions or engaging in direct negotiations, investors can exert influence on managerial decisions and lobby for specific strategic choices, such as long-term investments into Research & Development activities (David, Hitt, & Gimeno, 2001).

Similar to Research & Development investments, strategies that aim to enhance the environmental and social performance of companies incur costs in the near term and yield (uncertain) benefits over the long term. Given their longer investment horizons, long-term oriented shareholders are thus more likely to support strategic choices that further corporate environmental and social performances (Johnson & Greening, 1999; Neubaum & Zahra, 2006; Oh, Chang, & Martynov, 2011). Companies with a larger share of long-term oriented shareholders are thus more likely to invest in decarbonisation measures and achieve lower corporate carbon emissions.

> *Hypothesis 3:* The long-term orientation of shareholders is negatively associated with corporate carbon emissions.

## 3.3 Methods

### 3.3.1 Sample and Data

In order to test these hypotheses, I collected company-level data for the period 2010 to 2018 from Thomson Reuters EIKON and S&P Capital IQ[15]. In an effort to capture an extended time frame, the year 2010 was chosen as a starting point for two reasons. First, it followed the global financial crisis in 2008-2009 and marked the beginning of a period

[15] Data on corporate carbon emissions, investor holdings, and financial data was retrieved from Thomson Reuters EIKON database. To construct the measure for CEO time orientation, earning call transcripts were retrieved from Thomson Reuters EIKON database and S&P Capital IQ.

without major economic shocks that lasted until 2018, the last year for which data was available. Second, the economic contraction in the wake of the global financial crisis resulted in a 1.4% decrease of global carbon emissions in 2009, which bounced back with a year-on-year growth of 5.9% in 2010 (Peters et al., 2012) and have increased at an annual rate of 0.9% since 2010 (Peters et al., 2020). To avoid confounding the analysis with the sharp drop of carbon emissions caused by the global financial crisis, the year 2010 was chosen as the start date for the analysis.

The sampling approach was guided by four criteria. First, I focused on companies operating in carbon-intensive industries with long-lived assets (GICS Industry Groups: Energy, Materials, Utilities) because their business activities have material impacts on climate change. Almost 50% of annual anthropogenic greenhouse gas emissions can be traced back to two economic sectors (IPCC, 2014b) – Industry and Electricity & Heat Production – which include industries such as utilities and basic materials. In 2013, companies in the energy, materials, and utilities sectors accounted for 87.5% of the total emissions of the world's largest 500 companies (CDP & PwC, 2013). This suggests that a relatively small number of carbon-intensive industries are key contributors to climate change and, in turn, it implies that these industries will be key for decarbonising our economies (Dietz et al., 2018; Ekwurzel et al., 2017). Furthermore, I focused on companies with operations that are characterised by a similar reliance on long-lived assets. This helped to reduce the risk of confounding the relationship between organisational time orientation and carbon emissions due to underlying differences in asset durability (DesJardine & Bansal, 2019).

Second, I delimited the study to publicly listed companies with headquarters in member states of the European Union (EU). Establishing a level institutional playing field – both in terms of regulatory environment and corporate governance – limited extraneous variation (Eisenhardt, 1989). This is particularly relevant when examining carbon emissions as an outcome variable, since regulatory designs such as the European Union Emission Trading Scheme are important contextual factors of corporate climate action (Bui & Villiers, 2017; Slawinski et al., 2017). Likewise, corporate governance variables like ownership can influence corporate environmental strategies (Calza, Profumo, & Tutore, 2016) and, in this respect, publicly listed companies face similar institutional constraints through their exposure to capital markets. Moreover, empirical work on the link between organisational time orientation and corporate sustainability has so far been largely focused on North America (Ortiz-de-Mandojana et al., 2019; Slawinski & Bansal, 2012, 2015). Considering that time orientation is an inherently cultural phenomenon (Bluedorn, 2002), an examination of the time-climate change nexus in firms in the cultural contexts of Europe was deemed to be a valuable contribution to extant research.

Third, I restricted inclusion into the sample to companies with a market capitalisation of €1 billion or more to account for the fact that institutional investors are often not allowed to invest in companies below a certain market capitalisation threshold. Fourth, I required that firms had no missing carbon emission data for any year from 2010-2018. The application of list-wise deletion to remove firm-years with missing data resulted in a final sample of 68 companies and an unbalanced panel data set with 590 firm-year observations in total.

### 3.3.2 Outcome Variable

In line with this study's theoretical outlook, the empirical focus is placed on the impacts of companies on climate change measured as corporate carbon emissions in metric tons of $CO_2$ equivalents[16]. This measure comprises direct carbon emissions from sources

[16] $CO_2$ equivalent is a measure that converts various greenhouse gas emissions (based on their Global Warming Potential) into the equivalent amount of $CO_2$. The $CO_2$ equivalent measure used in this study

directly owned by companies (Scope 1) and indirect emissions from the generation of purchased energy (Scope 2), but it does not include emissions originating from companies wider value chain (Scope 3), such as emissions associated with supply chains or product usage (WRI & WBCSD, 2004). To account for the skewed distribution of corporate carbon emissions, I use the natural logarithm of carbon emissions in the analysis. An alternative approach to mitigating the skewed distribution of emissions is the use of emission ratios that measure corporate emissions relative to business metrics (Busch & Lewandowski, 2018; Hoffmann & Busch, 2008). For example, carbon intensity is a widely used indicator that captures the amount of carbon a company emits in generating one unit of a chosen business metric (e.g. revenues). Relative carbon indicators have several benefits,[17] but they do not capture a company's actual impact on climate change. In fact, a company can reduce its carbon intensity while simultaneously increasing the amount of carbon it releases into the atmosphere as long as the increase of the business metric in the denominator is greater than the increase of carbon emissions in the numerator of the emission ratio. Consistent with this study's analytical focus on the biophysical impacts of corporate activities on climate change, the outcome variable is operationalised using an absolute – rather than relative – carbon emission indicator that measures emissions in metric tons of $CO_2$ equivalents.

### 3.3.3 Explanatory Variables

The explanatory variables measure antecedents to organisational time orientation on three dimensions: individual, organisational, and institutional.

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included the following gases: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCS), perfluorinated compound (PFCS), sulfur heexafluoride ($SF_6$), nitrogen trifluoride ($NF_3$).

[17] Relative carbon indicators allow to compare the emission performance of companies while controlling for size differences, changes in economic conditions, changes in carbon emissions resulting from mergers and acquisitions, outsourcing, and other business restructuring activities (Busch & Lewandowski, 2018; Hoffmann & Busch, 2008).

*CEO Temporal Focus*

The analysis of psychological characteristics of senior executives is challenging, since persons in these positions usually operate under significant time constraints, which makes conducting interviews or getting responses to survey instruments difficult. The use of unobtrusive measures, which neither influences the reactions from research subjects nor requires their cooperation, circumvent these difficulties by drawing on archival data to examine psychological constructs (Hill, White, & Wallace, 2014). Unobtrusive measures have been increasingly used in O&M research to analyse psychological attributes of senior managers, such as narcissism (Chatterjee & Hambrick, 2007), attention focus (Nadkarni & Barr, 2008), and various time-related constructs (Gamache & McNamara, 2019; Nadkarni et al., 2016).

I follow prior O&M research and employ an unobtrusive measure to analyse CEOs' temporal focus based on word usage in earning conference calls with investors (Nadkarni & Chen, 2014). This analytical strategy is grounded in a psycholinguistic approach that allows for deducing psychological characteristics from individuals' use of language (Pennebaker, Mehl, & Niederhoffer, 2003). Understanding language as the very medium through which internal thoughts and emotions manifest in the external world, a psycholinguistic approach analyses verbal and written speech to generate insights into individual-level psychological constructs (Pennebaker & King, 1999; Tausczik & Pennebaker, 2010). Importantly, "studies on the psychometrics of word use suggest that people's word choice is sufficiently stable over time and consistent across topic or context to use language as an individual difference measure" (Pennebaker et al., 2003, p. 556).

To arrive at a language-based measure of the temporal focus of CEOs, I analyse CEO speech extracted from earning conference calls with investors. In these calls CEOs and other senior managers present the latest results in the context of companies' short- and long-term strategies, which makes these calls valuable source material for capturing participants' temporal focus (Brochet et al., 2015; DesJardine & Bansal, 2019). Moreover, earning conference calls are at least partially unscripted, since investors have the opportunity to ask questions directly to senior managers. This partially unscripted character reduces the risk that speech extracted from these calls is dominated by managerial efforts to manage impressions, thus offering a useful window into managers' cognition (DesJardine & Bansal, 2019). I retrieved earning conference call transcripts from Thomson Reuters EIKON and S&P Capital IQ and subsequently extracted the portions of text that were clearly attributable to CEOs. These extracts were then collated in separate information sets, each comprising the CEO speech from the respective company in a given year (e.g. CEO A of Company B in Year 2010)[18].

I analysed CEO speech with the Language Inquiry Word Count (LIWC) software to obtain measures of CEOs' temporal focus. The LIWC is a computerised text analysis tool that evaluates a body of text word by word against dictionaries that comprise collections of words representing certain categories (Tausczik & Pennebaker, 2010). The number of words representing each category is then expressed as a percentage of the total number of words in the analysed body of text. The dictionaries included in the LIWC tool measure both linguistic attributes and psychological constructs, including past focus (e.g. "ago", "did", "talked"), present focus (e.g. "today", "is", "now"), and future focus (e.g. "may", "will", "soon") (Pennebaker, Boyd, Jordan, & Blackburn, 2015). I utilised the LIWC temporal focus dictionaries, which are consistent with the definition of CEO past, present,

[18] Given the longitudinal character of the analysis (2010-2018), the individuals holding CEO positions changed in some companies. To allow for a clear attribution of speech to a particular CEO in a given year, the following approach is adopted: If change of CEO occurred in first half of the year, the speech of outgoing CEO is attributed to the previous year. For instance, if a CEO stepped down in April 2012, any speech of this CEO between January and April 2012 is included in the information set capturing the year 2011. If change of CEO occurred in the second half of the year, the speech of outgoing CEO is attributed to the current year and the speech of incoming CEO is attributed to the subsequent year. For example, if incoming CEO starts job in August 2012, any speech of this CEO between August and December 2012 is included in information set capturing the year 2013.

and future focus in Section 3.2.3 and have been used in prior O&M studies (Gamache & McNamara, 2019; Nadkarni & Chen, 2014). The key explanatory variable for testing this study's hypotheses is *CEO future focus*, representing the importance that a CEO attributes to the future.

*Executive Compensation Structure*

I measure the time orientation of executive compensation with two binary measures that are both retrieved from Thomson Reuters EIKON database. The first measure captures whether the remuneration of management and board members is partly linked with targets that are more than two years forward-looking (*long term compensation*). The second measure checks if a company has an executive compensation policy that includes sustainability or Environmental, Social, and Governance (ESG) factors (*ESG compensation*).

*Ownership Structure*

The time orientation of shareholders has commonly been inferred from the different types of investors (Johnson et al., 2010), with pension funds often classified as long-term investors and mutual funds, investment banks, or hedge funds frequently categorised as short-term investors (e.g. Hoskisson et al., 2002; Johnson & Greening, 1999; Neubaum & Zahra, 2006). However, Bushee (1998) argued that there can be differences in temporal preferences within the respective types of investors and instead proposed to classify investors based on their past trading behaviour. I follow Bushee's approach and use the investor turnover measure provided by Thomson Reuters EIKON to categorise shareholders of each company into three groups based on their portfolio trading behaviour over the previous 36 months: 1) *Short term investors*: annual portfolio turnover rate is greater than 100% and average holding period less than two years, indicative of short-term orientation; 2) *Medium term investors*: annual portfolio turnover rate between 50 – 100% and average holding period between one and two years, indicative of medium-term orientation; 3)

*Long term investors*: annual portfolio turnover rate is less than or equal to 50% and average holding period longer than two years, indicative of long-term orientation. Aggregating the percentage of shares held by each of these groups in each firm and year, I derive three variables measuring the percentage of long-term, medium-term, and short-term oriented shareholders for each firm-year. The focal variable of interest is *long-term investors*, representing percentage of shareholders with a long-term orientation.

### 3.3.4 Control Variables

I control for several variables that could influence companies' carbon emissions. Expecting that firm *size* in carbon-intensive industries is a substantial determinant of carbon emissions, I include the natural logarithm of total assets as a control variable. Financially successful companies have more organisational slack to make long-term investments (Souder & Shaver, 2010) to improve the social performance of companies (Waddock & Graves, 1997) or decarbonise business models. I thus control for profitability, measured as *Return on Assets* (ROA), and *leverage*, measured as the ratio of total debt to total assets (Oh et al., 2011).

### 3.3.5 Analysis

To examine the relationship between corporate carbon emissions and organisational time orientation, I estimate a fixed effects regression model:

$$CO2_{it} = \alpha_i + \alpha_t + \beta TIME_{it} + \gamma Z_{it} + \varepsilon_{it}$$

where *i* refers to the *i*th firm and t denotes the time. carbon is the outcome variable, which represents corporate carbon emissions, $\alpha_i$ are firm fixed effects, $\alpha_t$ are year fixed effects. TIME is the set of explanatory variables that represent the temporal orientation of companies as previously explained. The coefficient β captures the effect of changes in organisational time orientation on corporate carbon emissions. Z is a vector containing all control variables, which includes *size*, *ROA*, and *leverage* as previously explained (see also Appendix). ε(t) is the error term. Supported by the Hausman test ($\chi 2 = 24.385$; $p < 0.0004$), I use a fixed effects model that removes the effects of any time invariant firm factors and allows me to estimate the net effects of organisational time orientation on corporate carbon emissions (Allison, 2009). To account for heteroscedasticity, serial autocorrelation and contemporaneous correlations, I cluster standard errors at the firm level and include year fixed effects in the regression model (Certo & Semadeni, 2006).

## 3.4 Results[19]

The summary statistics and correlations for all variables are reported in Table 3.2. Results from the fixed effects regression model are presented in Table 3.3. Model 1 comprises only the control variables and constitutes the baseline model. Model 2 – 4 progressively include the explanatory variables of the analysis, beginning with CEO temporal focus (Model 2), subsequently adding the compensation variables (Model 3), and then complementing the final model with the temporal orientation of shareholders (Model 4).

Hypothesis 1 suggests that CEO future focus is negatively associated with carbon emissions. I find that the coefficient of the variable *CEO future focus* is negative and significant at the .05 level in Model 4 ($\beta = -0.068$, $p = 0.016$), indicating that companies with CEOs who had a stronger future focus generated less carbon emissions. This finding supports Hypothesis 1.

Hypothesis 2a proposes that long-term executive compensation is negatively associated with carbon emissions. In Model 4, the coefficient of the variable *long-term compensation* is negative but not significant and Hypothesis 2a is thus not supported. Contrary to the relationship proposed in Hypothesis 2b, I find that the integration of sustainability criteria

[19] All tables referenced in this section are included in the appendix at the end of Chapter 4.

into executive compensation is positively, instead of negatively, related to carbon emissions in Model 4. The coefficient of the variable *ESG compensation* is positive and significant at the .01 level (β = 0.171, p = 0.008), showing that companies with executive compensation tied to sustainability criteria emitted more carbon.

Hypothesis 3 suggests that the long-term orientation of shareholders is negatively associated with carbon emissions. Model 4 indicates that the coefficient of the variable *long-term investors* is negative, but I note that it is only significant at the .1 level (β = –0.454, p = 0.09). Acknowledging that this is weaker evidence than in the case of the other explanatory variables, I cautiously conclude that this result provides support for Hypothesis 3. Hence, companies with a larger share of long-term oriented shareholders produced less carbon emissions.

In terms of control variables, the size of companies is positively associated with carbon emissions and the coefficient is significant at the .01 level (β = 1.150, p = 0.000). The coefficient of *ROA* is positive, and the coefficient of *Leverage* is negative, but neither of them is statistically significant. The coefficients of the year fixed effects are negative and highly significant, suggesting that there is an underlying trend that is negatively associated with carbon emissions. This trend is more pronounced from 2014 onwards, with coefficient values increasing consistently from β = –0.117 for the *Year 2013* to β = –0.484 for the *Year 2018*.

### 3.4.1 Robustness checks

To check whether the results are driven by the relatively large number of variables, I ran the regression analysis but included only the statistically significant variables from Model 4. This yielded very similar coefficients and significance levels, with only the coefficient of long-term investors indicating a more substantial change from β = –0.454 to β = –0.385 (see column 5 in Table 3.3).

Several companies in the sample sold parts of their business between 2015 and 2018, resulting in substantial carbon emission reductions[20]. Controlling for these divestment-driven emission reductions, the model yielded similar results for most parameters, but the coefficient value of *long-term investors* is lower and no longer significant. Likewise, the control variable *ROA* is positively associated with carbon emissions and significant at the .05 level ($\beta = 0.011$, $p = 0.023$) in this model.

To control for the possibility that organisational time orientation has a delayed effect on carbon emissions, I repeated the analysis with the explanatory variables lagged one year behind the outcome variable. While the coefficient of *ESG compensation* remain unchanged, the coefficient values of *CEO future focus* and *long-term investors* become smaller and are no longer significant (see Table 3.4).

## 3.5 Discussion

This study examines the relationship between organisational time orientation and corporate carbon emissions. Estimating a fixed effects regression model of an unbalanced panel data set, I find that a long-term orientation of CEOs and shareholders is negatively associated with corporate carbon emissions, whereas the inclusion of sustainability factors into executive compensation is positively related to carbon emissions. This partly supports the theorising that companies attributing greater importance to the future are more inclined to decarbonise their business models and have lower carbon emissions.

The negative relationship between future-focused CEOs and carbon emission is consistent with prior research findings that companies led by CEOs with future time perspectives are more likely to invest in measures that reduce carbon emissions (Ortiz-de-Mandojana et al., 2019). This finding also confirms prior research demonstrating the

[20] Including: Akzo Nobel N.V. in 2018, Koninklijke DSM N.V. in 2015, E.ON SE in 2016, and Svenska Cellulosa AB in 2017.

importance of CEOs temporal preferences for strategic decision-making (Gamache & McNamara, 2019; Nadkarni & Chen, 2014) and provides empirical support for the proposition that companies with future-focused CEOs are more inclined to take effective climate action that result in lower corporate carbon emissions (Slawinski et al., 2017).

Contrary to the formulated hypothesis and prior studies (Flammer et al., 2019), I find that the integration of sustainability criteria into executive compensation is positively, instead of negatively, related to corporate carbon emissions. This indicates that companies in which executive compensation is partly determined by sustainability criteria tend to have *higher* carbon emissions. A possible explanation is that sustainability criteria account only for a small share of total executive compensation, which is unlikely to effectively incentivise senior management to adopt a long-term orientation.[21] Similarly, the way in which sustainability criteria are integrated into executive compensation can influence the effectiveness of incentive structures in directing managerial attention towards long-term sustainability outcomes. For example, Maas (2018) found that the inclusion of hard, quantitative sustainability targets (e.g. carbon emission reductions by a certain amount or percentage by a specific point in time) into executive compensation has a positive effect on corporate sustainability performance, whereas this effect is negative when soft, qualitative sustainability targets (e.g. improving sustainability rating) are used. The finding that sustainability criteria in executive compensation policies are associated with higher carbon emissions may reflect a more symbolic rather than substantive use of sustainability-linked incentives (Bowen, 2014). Instead of reorienting managerial attention to long-term organisational outcomes – thereby increasing the propensity to take effective climate

[21] Considering the possibility of reverse causality, an alternative explanation may be that companies with high carbon emissions are more likely to introduce sustainability criteria into executive remuneration package to incentivise senior managers to reduce emissions. However, when lagging the explanatory variables one year behind the outcome variable, the variable ESG compensation remains positively and significantly associated with corporate carbon emissions (cf. Table 3), providing further support for the interpretation of the results outlined above.

action – sustainability criteria may be integrated into executive compensation to signal a superficial environmental commitment and deflect stakeholder pressure regarding climate change (Berrone & Gomez-Mejia, 2009).

The finding that the long-term orientation of shareholders is negatively associated with carbon emissions is consistent with prior research documenting a positive relationship between long-term oriented shareholders and corporate sustainability performance (Johnson & Greening, 1999; Neubaum & Zahra, 2006; Oh et al., 2011). However, my results differ from prior studies that disaggregated corporate sustainability performance and focused explicitly on the link between ownership structures and corporate environmental performance. While these studies reported no significant effects of long-term oriented shareholders on corporate environmental performance (Calza et al., 2016; Walls, Berrone, & Phan, 2012), I find that the long-term orientation of shareholders is related to lower corporate carbon emissions. I note, however, that this result is only significant at the .1 level.[22]

Prior research has lagged time orientation as an explanatory variable, arguing that temporal preferences take time to materialise in strategic action and organisational outcomes (DesJardine & Bansal, 2019). This argument seems to be equally relevant in the context of my study, since it is plausible that investments in decarbonisation measures by long-term oriented companies may have delayed effects on corporate carbon emissions. For example, investments in new production technologies may take several years before resulting in carbon emission reductions since new facilities and machinery need to be installed. However, lagging the explanatory variables one year (cf. Table 3.4) and two years

[22] It should be noted that Walls et al. (2012) reported the significance of their results at the .1 level, whereas Calza et al. (2016) indicated only .05 and .01 significance level. There is a possibility that Calza et al.'s test for the relationship between long-term oriented shareholders and environmental performance is significant (but unreported) at the .1 level, in which case my findings would be consistent with their analysis.

(untabulated analysis) behind the outcome variable, I find only limited support for this proposition. While the positive relationship between sustainability compensation and carbon emissions remained highly significant, the negative relationships between CEO future focus and long-term investors were no longer statistically significant. Combined with the findings in the main model, this indicates that there is no substantial time lag between organisational time orientation and corporate carbon emissions. A possible explanation is that companies focused on taking measures that materialised relatively quickly in terms of lower carbon emissions, such as divesting of business units[23] or purchasing more renewable energy (Cadez & Czerny, 2016).

Regarding the control variables included in the regression model, I find that larger companies emit more carbon emissions. This is unsurprising since the companies included in the sample operate in industries in which carbon emissions are tightly linked with production assets, such as blast furnaces in the steel industry or power plants in the utility sector. I also find that the year fixed effects are negative and highly significant from 2013 onwards, indicating that there are factors outside the model that have a negative effect on corporate carbon emissions. While it is difficult to identify these factors from my analysis, there are two possible explanations that come to mind. First, in the wake of the 2015 Paris Agreement – the first-ever legally binding climate change agreement – climate change has risen to unprecedented prominence on public policy agendas in Europe. The adoption of more ambitious climate change agendas has also been reflected in rising prices of emission allowances in the European Union Emission Trading Scheme (ETS). Following reduced allocations of emission allowances, the price for emission allowances has increased from approximately €5 to over €15 per ton of $CO_2$ equivalent between 2013 and 2018

[23] A supplementary analysis of the firm-years with the highest year-on-year decreases in carbon emission supports this explanation, with the majority of emission reductions resulting from divestments, reductions of energy consumption, and transitions to using lower carbon fuels. For example, Drax plc, a UK-based utility, reduced its carbon emissions by 53% in 2016 by replacing coal with biomass to power three out of six power generating units.

(Healy, Graichen, Graichen, Nissen, & Gores, 2019). This increase corresponds with the negative and highly significant coefficients of the fixed year effects in the analysis. Given that the industries included in the sample are subject to the European Union ETS, the increase of emission allowance prices together with a more ambitious climate policy agenda might have been a key driver of the negative influence on corporate carbon emission that is captured by the fixed year effects in the analysis.

There are several limitations of the study that warrant discussion. First, the study examines Scope 1 and Scope 2 carbon emissions, but it does not consider Scope 3 emissions in the analysis. The latter captures emissions emanating from wider value chains, including supply chains (upstream) and product usage (downstream), which can constitute the majority of companies' climate change impacts. While limiting the analysis to Scope 1 and Scope 2 emissions yields only a partial picture of an organisation's contribution to climate change, including Scope 3 data in the analysis is not feasible because only very few companies consistently report Scope 3 carbon emission data.

Second, and related to the previous point, the availability of carbon emission data poses challenges since the sampling approach required companies to have a full set of carbon emission data over the time frame of the analysis (2010 – 2018). Although carbon emission reporting was mandatory for publicly listed companies in certain EU member states in some years (e.g. in the UK from 2012 onwards), there was no mandatory EU-wide carbon emission reporting requirement in place during the research period 2010 – 2018. This introduces the possibility of a self-selection bias in the analysis, since companies with higher and/or increasing emissions might have been reluctant to voluntarily disclose carbon emissions, resulting in a biased sample that excludes companies with high or increasing carbon emissions. Considering the sampling focus on large publicly listed companies and the significant stakeholder pressures on companies to disclose carbon emissions[24], especially in a European context, the risk of a self-selection bias is considered to be low.

Finally, the main model cannot analytically rule out reverse causality. While I interpret the results as evidence that organisational time orientation affects corporate carbon emissions, an alternative interpretation may be that corporate carbon emissions are the causal driver of organisational time orientation. However, it is hard to see how corporate carbon emissions could causally influence organisational time orientation and in the absence of a compelling conceptual argument that explains this direction of the causal relationship, this issue is considered to be mitigated.

Taking into account these limitations, this study makes several contributions to the literature. First, it is one of the first studies to empirically test the relationship between organisational time orientation and corporate climate action. While prior studies have emphasised the importance of temporal factors for enhancing business sustainability (Bansal & DesJardine, 2014) and taking effective climate action (Slawinski et al., 2017), these conceptual arguments have rarely been examined empirically (Ortiz-de-Mandojana et al., 2019; Sarasini & Jacob, 2014; Slawinski & Bansal, 2012, 2015). By showing that the long-term orientation of CEOs and shareholders is negatively related to corporate carbon emissions, this study provides empirical support for the notion that long-term oriented companies are more likely to take effective climate action, which is reflected in lower corporate carbon emissions.

Second, this study responds to calls for O&M research to take planetary boundaries seriously and pay close attention to the impacts of corporate activities on the natural environment (Bansal & Knox-Hayes, 2013; Whiteman et al., 2013; Winn & Pogutz, 2013). By

[24] In 2018, 850 companies in Europe, representing 75% of total market capitalization, disclosed carbon emissions through CDP, a non-profit organisation operating the world's largest environmental disclosure system (CDP, 2019a).

examining the relationship between organisational time orientation and the biophysical impacts of companies on climate change in form of corporate carbon emissions, this study puts the ecological impacts of companies at the heart of the analysis and bridges the gap between O&M research and natural (climate) science. This research contributes to the curiously small number of O&M studies examining how organisational features influence corporate carbon emissions and adds to findings that certain organisational processes, such as more ambitious target setting, are associated with lower carbon emissions (Dahlmann et al., 2017; Ioannou et al., 2016).

Third, the study contributes to the growing literature on the role of time in organisation and strategic management. While empirical research on various temporal aspects of strategic management has flourished in recent years, the majority of these studies have examined North American companies (DesJardine & Bansal, 2019; Flammer & Bansal, 2017; Gamache & McNamara, 2019; Souder & Bromiley, 2012; Zhang & Gimeno, 2016). Likewise, discussions around corporate short-termism, which has stimulated much of O&M research on time (Laverty, 1996), has been firmly grounded in a U.S. context (Hayes & Abernathy, 1980; Porter, 1992). However, perceptions and experiences of time differ between cultural settings (Bluedorn, 2002). By examining the time-climate change nexus in European firms, this study contributes insights from a different cultural context to the extant literature.

## 3.6 Conclusion

The world is currently on track to reach 3 degrees of warming by the end of the century (Climate Action Tracker, 2019) and the biophysical impacts of climate change are already being felt across the globe (WMO, 2020). To mitigate global warming and its devastating impacts on natural and human systems, companies need to drastically reduce carbon emissions, eventually reaching net zero emissions around 2050 (Millar et al., 2016). While business activities are major sources of carbon emissions, and thus key contributors to global warming, little is known under which conditions companies (fail to) reduce carbon emissions. Examining the relationship between organisational time orientation and corporate carbon emissions, this study provides empirical support for the notion that long-term oriented companies are more likely to invest in decarbonisation measures and generate less carbon emissions.

While this study offers first empirical insights into how temporal factors influence corporate carbon emissions, the findings call for more O&M research that takes climate science seriously and places the biophysical outcomes of organisations at the heart of empirical analyses. This is all the more important considering the surge of corporate announcements that pledge a commitment to achieving net zero emissions (SBTi, 2021). While these commitments are welcome, it remains to be seen whether they are followed by effective actions that deliver carbon emission reductions or if these pledges are just another permutation of symbolic corporate environmentalism without substantially mitigating climate change (Bowen, 2014; Bowen & Aragon-Correa, 2014). O&M research is principally well positioned to explore this question and more research is needed into why, when, and how companies (fail to) achieve carbon emission reductions.

## 3.7 Appendix Chapter 3

### 3.7.1 Appendix A: Variable Definitions

**Table 3.1: Variable Definitions**

| Variable | Definition |
|---|---|
| CO2 | Natural logarithm of CO2 emissions (Scope 1 and Scope 2). |
| CEO past focus | Importance that a CEO attributes to the past. Measure derived from textual analysis of CEO speech using Language Inquiry Word Count (LIWC) software. |
| CEO present focus | Importance that a CEO attributes to the present. Measure derived from textual analysis of CEO speech using Language Inquiry Word Count (LIWC) software. |
| CEO future focus | Importance that a CEO attributes to the future. Measure derived from textual analysis of CEO speech using Language Inquiry Word Count (LIWC) software. |
| Long term compensation | Indicator variable that equals one if the remuneration of management and board members is partly linked with targets that are more than two years forward-looking. |
| ESG compensation | Indicator variable that equals one if company has an executive compensation policy that includes Environmental, Social, and Governance (ESG) factors |
| Short term investors | Percentage of shares held by investors with annual portfolio turnover rate is greater than 100%, average holding period less than two years, indicative of short-term orientation. |
| Medium term investors | Percentage of shares held by investors with annual portfolio turnover rate between 50 – 100% and average holding period between one and two years. |
| Long term investors | Percentage of shares held by investors with annual portfolio turnover rate is less than or equal to 50%, average holding period longer than two years, indicative of long-term orientation |
| Size | Natural logarithm of total assets. |
| ROA | Return on assets. Expressed as percentage. |
| Leverage | Leverage calculated as total debt divided by total assets. |

### 3.7.2 Appendix B: Tables

List of tables included in Chapter 3:

- Table 3.2: Descriptive Statistics and Correlations
- Table 3.3: Results of fixed effects regression
- Table 3.4: Results of fixed effects regression with one-year lagged explanatory variables

**Table 3.2: Descriptive Statistics and Correlations**

| Variables | Mean | SD | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) CO2 | 15.51 | 1.92 | 1.00 | | | | | | | | | | | |
| (2) CEO past focus | 2.37 | .66 | -0.10* | 1.00 | | | | | | | | | | |
| (3) CEO present focus | 9.96 | 1.51 | -0.13* | 0.18* | 1.00 | | | | | | | | | |
| (4) CEO future focus | 1.95 | .48 | 0.03 | -0.16* | 0.04 | 1.00 | | | | | | | | |
| (5) Long term compensation | .03 | .18 | -0.01 | -0.01 | 0.11* | -0.03 | 1.00 | | | | | | | |
| (6) ESG compensation | .6 | .49 | 0.13* | 0.10* | -0.04 | -0.01 | 0.07 | 1.00 | | | | | | |
| (7) Long term investors | .53 | .18 | -0.09* | 0.13* | -0.07 | -0.03 | -0.07 | 0.06 | 1.00 | | | | | |
| (8) Medium term investors | .06 | .07 | -0.19* | 0.17* | 0.15* | -0.09* | 0.05 | 0.01 | -0.25* | 1.00 | | | | |
| (9) Short term investors | .01 | .03 | -0.01 | -0.02 | 0.02 | 0.03 | -0.02 | -0.01 | -0.11* | 0.11* | 1.00 | | | |
| (10) Size | 9.83 | 1.31 | 0.83* | -0.13* | -0.17* | 0.11* | -0.04 | 0.17* | -0.11* | -0.28* | -0.04 | 1.00 | | |
| (11) ROA | 4.31 | 4.72 | -0.31* | 0.00 | 0.14* | -0.02 | 0.04 | 0.01 | -0.01 | 0.19* | -0.01 | -0.35* | 1.00 | |
| (12) Leverage | .28 | .13 | -0.21* | 0.14* | -0.07 | 0.10* | -0.12* | 0.03 | -0.04 | 0.00 | 0.07 | 0.03 | -0.25* | 1.00 |

* shows significance at the .05 level

**Table 3.3: Fixed Effects Regression Results**

Table 3.3 presents the results from regressing CO2 emissions on companies' temporal orientation. Column (1) regresses *CO2* on the control variables *Size*, *ROA*, and *Leverage*; column (2) adds CEO temporal focus; column (3) adds variables capturing the company's compensation structure; column (4) adds variables capturing the temporal orientation of shareholders. Column (5) includes only the statistically significant variables from column (4). Robust standard errors are reported in parentheses and the respective year fixed effects are reported in each of the four columns. All variables are defined in detail in Appendix.

| VARIABLES | (1)<br>CO2 | (2)<br>CO2 | (3)<br>CO2 | (4)<br>CO2 | (5)<br>CO2 |
|---|---|---|---|---|---|
| Size | 1.210*** | 1.203*** | 1.136*** | 1.150*** | 1.122*** |
| | (0.333) | (0.331) | (0.321) | (0.314) | (0.290) |
| ROA | 0.009 | 0.009 | 0.008 | 0.009 | |
| | (0.007) | (0.007) | (0.007) | (0.006) | |
| Leverage | -0.353 | -0.338 | -0.220 | -0.225 | |
| | (0.709) | (0.713) | (0.719) | (0.714) | |
| CEO future focus | | -0.058* | -0.054* | -0.068** | -0.061** |
| | | (0.031) | (0.030) | (0.027) | (0.027) |
| CEO present focus | | 0.015 | 0.017 | 0.015 | |
| | | (0.018) | (0.017) | (0.018) | |
| CEO past focus | | -0.017 | -0.000 | 0.009 | |
| | | (0.043) | (0.041) | (0.040) | |
| Long term compensation | | | -0.097 | -0.101 | |
| | | | (0.140) | (0.142) | |
| ESG compensation | | | 0.170*** | 0.171*** | 0.176*** |
| | | | (0.063) | (0.063) | (0.062) |
| Long term investors | | | | -0.454* | -0.385* |
| | | | | (0.264) | (0.214) |
| Medium term investors | | | | -0.264 | |
| | | | | (0.288) | |
| Short term investors | | | | 0.575 | |
| | | | | (0.523) | |
| Year 2011 | -0.057 | -0.062 | -0.077* | -0.080* | -0.074* |
| | (0.040) | (0.041) | (0.042) | (0.045) | (0.040) |
| Year 2012 | -0.091* | -0.095* | -0.112** | -0.088 | -0.091* |
| | (0.051) | (0.051) | (0.051) | (0.054) | (0.047) |
| Year 2013 | -0.089* | -0.098* | -0.119** | -0.117** | -0.131*** |
| | (0.052) | (0.052) | (0.051) | (0.051) | (0.045) |
| Year 2014 | -0.208*** | -0.214*** | -0.238*** | -0.223*** | -0.233*** |
| | (0.073) | (0.072) | (0.069) | (0.068) | (0.060) |
| Year 2015 | -0.256*** | -0.259*** | -0.302*** | -0.272*** | -0.295*** |
| | (0.094) | (0.094) | (0.093) | (0.089) | (0.079) |
| Year 2016 | -0.336*** | -0.341*** | -0.387*** | -0.340*** | -0.341*** |
| | (0.107) | (0.108) | (0.108) | (0.102) | (0.095) |
| Year 2017 | -0.342*** | -0.349*** | -0.403*** | -0.373*** | -0.373*** |
| | (0.119) | (0.119) | (0.122) | (0.115) | (0.109) |
| Year 2018 | -0.467*** | -0.465*** | -0.518*** | -0.484*** | -0.486*** |
| | (0.132) | (0.131) | (0.137) | (0.128) | (0.119) |
| Constant | 3.882 | 3.968 | 4.460 | 4.568 | 4.921* |
| | (3.104) | (3.078) | (2.987) | (2.875) | (2.761) |
| Adjusted $R^2$ | 0.751 | 0.753 | 0.752 | 0.754 | 0.687 |
| Observations | 590 | 590 | 590 | 590 | 590 |

Standard errors in parentheses. Standard errors clustered at the firm level.
*** p<0.01, ** p<0.05, * p<0.1

**Table 3.4: Fixed Effects Regression Results with Lagged Explanatory Variables**

Table 3.4 presents the results from regressing CO2 emissions on companies' temporal orientation with all explanatory and control variables lagged one year behind the outcome variable. Lagging the explanatory and control variables reduced the number of firm-year observations from 590 to 516. Column (1) regresses *CO2* on the control variables *Size*, *ROA,* and *Leverage*; column (2) adds CEO temporal focus; column (3) adds variables capturing the company's compensation structure; column (4) adds variables capturing the temporal orientation of shareholders. Robust standard errors are reported in parentheses and the respective year fixed effects are reported in each of the four columns. All variables are defined in detail in Appendix.

| VARIABLES | (1)<br>CO2 | (2)<br>CO2 | (3)<br>CO2 | (4)<br>CO2 |
|---|---|---|---|---|
| Size | 1.297*** | 1.286*** | 1.210*** | 1.229*** |
| | (0.354) | (0.347) | (0.319) | (0.322) |
| ROA | 0.005 | 0.004 | 0.003 | 0.003 |
| | (0.008) | (0.008) | (0.008) | (0.008) |
| Leverage | -0.206 | -0.283 | -0.198 | -0.207 |
| | (0.651) | (0.644) | (0.622) | (0.620) |
| CEO future focus | | -0.033 | -0.025 | -0.027 |
| | | (0.035) | (0.036) | (0.037) |
| CEO present focus | | 0.037* | 0.037* | 0.036* |
| | | (0.019) | (0.019) | (0.018) |
| CEO past focus | | -0.005 | 0.018 | 0.023 |
| | | (0.042) | (0.042) | (0.042) |
| Long term compensation | | | 0.013 | 0.016 |
| | | | (0.057) | (0.057) |
| ESG compensation | | | 0.176*** | 0.173*** |
| | | | (0.064) | (0.064) |
| Long term investors | | | | -0.037 |
| | | | | (0.222) |
| Medium term investors | | | | 0.208 |
| | | | | (0.312) |
| Short term investors | | | | 0.386 |
| | | | | (0.297) |
| Year 2011 | -0.070** | -0.079** | -0.096** | -0.083** |
| | (0.033) | (0.035) | (0.037) | (0.036) |
| Year 2012 | -0.062 | -0.072* | -0.095** | -0.065* |
| | (0.038) | (0.037) | (0.039) | (0.039) |
| Year 2013 | -0.194*** | -0.213*** | -0.232*** | -0.225*** |
| | (0.053) | (0.055) | (0.054) | (0.052) |
| Year 2014 | -0.252*** | -0.270*** | -0.294*** | -0.281*** |
| | (0.075) | (0.077) | (0.074) | (0.072) |
| Year 2015 | -0.320*** | -0.333*** | -0.377*** | -0.361*** |
| | (0.093) | (0.093) | (0.093) | (0.090) |
| Year 2016 | -0.314*** | -0.335*** | -0.387*** | -0.354*** |
| | (0.096) | (0.098) | (0.103) | (0.095) |
| Year 2017 | -0.448*** | -0.469*** | -0.523*** | -0.509*** |
| | (0.109) | (0.111) | (0.117) | (0.113) |
| Year 2018 | -0.070** | -0.079** | -0.096** | -0.083** |
| | (0.033) | (0.035) | (0.037) | (0.036) |
| Constant | 2.992 | 2.843 | 3.426 | 3.240 |
| | (3.351) | (3.331) | (3.080) | (3.120) |
| Adjusted $R^2$ | 0.743 | 0.746 | 0.745 | 0.745 |
| Observations | 516 | 516 | 516 | 516 |

Standard errors in parentheses. Standard errors clustered at the firm level.
*** p<0.01, ** p<0.05, * p<0.1

# 4 Climate Risk as Linguistic Cleansing: Strategic Responses to the Climate Crisis by Carbon-Intensive Corporations

## 4.1 Introduction

Since the signing of the 2015 Paris Climate Agreement, governments, investors, and consumers have stepped up pressure on publicly listed companies to respond to climate risks by substantially reducing carbon emissions (decarbonization). While an apparent logic of climate stewardship, also known as decarbonization or green transition, is on the rise (Ansari et al., 2013; Klein, 2014; Klein & Stefoff, 2021), shareholderism (Friedman, 1970) remains an ingrained institutional demand, with investors and "impatient capital" holding publicly listed corporations accountable for the financial value they create for shareholders (Bebchuck & Tallarita, 2020; Collier, 2019). Even advocates of the purposeful business movement (British Academy, 2019; Business Roundtable, 2019; Fink, 2019) uphold financial accountability by arguing that companies may create "profitable solutions for the planet", suggesting that "fair (or "sustainable") profits" should replace "fake profits" (Mayer, 2018). In practice, however, it is not clear if and when the environmental-financial–performance relationship is complementary or contradictory. The empirical evidence is patchy and mixed, suggesting that while under certain circumstances it may "pay to be green," there are contexts—particularly in manufacturing—in which decarbonization may bring losses (Hart, 1995; Hart & Dowell, 2011; Houlder & Livsey, 2021).

Regulation plays a key role in requiring businesses to decarbonize and, in the last few years, demands for regulation have intensified. Scientists tell us that in order to mitigate the catastrophic impacts of global warming, global anthropogenic carbon emissions need to reach net zero[25] around 2050 (Millar et al., 2016). In line with economists' assessment

[25] Reaching net zero emissions requires reducing carbon emissions to zero either by removing emitted carbon from the atmosphere (e.g., through emission offsetting or carbon capture and storage) or by eliminating it at the source.

that every year of delaying climate action makes it harder to reach carbon neutrality (Stern, 2011), policymakers have stepped up their efforts of curbing emissions. For example, the UK and France enshrined their commitments to eliminate greenhouse gas emissions by 2050 into national law in 2019 (Bate, 2019; Harrabin, 2019) and, in 2021, a European Climate Law came into force, which includes a legally binding target and supporting policies to reach net-zero emissions in the EU by 2050 (European Commission, 2021). Publicly listed companies are thus increasingly expected to reduce carbon emissions and support the transition to a low-carbon economy.

How, then, do high–carbon-intensity corporations reconcile growing institutional demands to reduce emissions (a climate-stewardship logic) with the constant pressure to create shareholder value (the longstanding logic of the market)?

This question is all the more important as anecdotal evidence suggests that decoupling is a common strategic response (Meyer and Rowan, 1977) to climate change; that is, a gap has been opening between companies' stated intentions to "fight climate change" (to quote Apple CEO Tim Cook's 2017 declaration) and what they actually do. In fact, executives and directors consistently report that the pressures to "produce short-term results" are increasing, precluding strategic decisions with a time horizon longer than three or four years (Bailey, Bérubé, Godsall, & Kehoe, 2014, p. 1). One market commentary goes as far as declaring, "Current market dynamics hamper and erode time intensive, life affirming practices contributing to the broader 2015 Paris Agreement objectives. Under existing market practices… any environmentally oriented CEO, must have a death wish to pursue such strategies" (van Gansbeke, 2021).

Meanwhile, global emissions continue to rise (Hodgson & Khan, 2019; Le Quéré et al., 2021; WMO, 2021). In the past, organizational inaction had been exacerbated by the fact that the effects of climate change have been, in general, intangible (Bryant, Griffin, &

Perry, 2019; Weinhofer & Busch, 2013). But in the last few years, rising global economic losses from severe weather events have been attributed to climate change (Bevere, Gloor, & Sobel, 2020). As institutional pressure on companies to fulfil ambitious decarbonization goals and ambitious financial commitments mount, there is disagreement on whether such demands can be compatible (British Academy, 2019; Henderson & Serafeim, 2020; Porter & Kramer, 2011) or cannot be (Crane, Palazzo, Spence, & Matten, 2014; Pache & Santos, 2010). Different institutional demands or logics[26] have been shown to elicit different strategic responses, ranging from compliance to resistance (Kraatz & Block, 2008; Oliver, 1991). The purpose of this paper is to identify the strategic responses of carbon-intensive manufacturers to the dual pressures of climate-stewardship and the market, and to develop a preliminary conceptual framework for explaining the variation.

Building upon the work of Oliver (1991) and Pache & Santos (2010; 2013), and our own exploratory study of 19 European carbon-intensive corporations in the chemical, steel, and utility industries, we develop an overview of responses through which firms— listed, profit-seeking companies—accommodate the pressure of decarbonization. The latter represents climate stewardship, the emerging logic which rose in the wake of the social and political movements that brought about the current nation- and EU-level commitments to decarbonization. Whether it is rival or complementary to the market logic is not yet clear. We pay attention to institutional logics as they have the capacity to "prescribe what constitutes legitimate behavior" and provide "taken-for-granted conceptions of what goals are appropriate and what means are legitimate to achieve these goals" (Pache & Santos,

[26] Early organizational literature uses the term “institutional demands” and “logics” interchangeably, but more recently researchers have taken to being more specific about their use by defining institutional logics in specific ways. For an overview and examples, see Thornton and Ocasio (2008). In the accounting literature, many follow the specify-and-define approach to institutional logics, as do Ezzamel et al. (2012), Amans et al. (2015), Carlsson-Wall, Kraus, and Messner (2016) and Järvinen, 2016. Yet others, following Oliver (1991), continue to apply the term “logics” as synonymous with institutional demands, e.g. Miller and Power (2013), Power (2015). In this paper, we use the term institutional logics as synonymous with institutional demands, but to clarify this, we follow the definition adopted by Pache and Santos (2013).

2013: p. 973). As the decarbonization challenge poses different resource and capability demands on different sectors, we expect—in line with Oliver (1991)—different strategic responses from different firms.

While this institutional complexity is the background of our study, our key argument is that firms reconcile the dual logics of climate stewardship and the market by the "managerialization" of the climate crisis: the transformation of the seemingly intractable system-level problem of climate change into an issue manageable by corporations. We posit that turning climate change into a management object requires various acts of quantification and observe the construction of a new management category, *climate risk*.

Given the plurality of logics – and values – that pervades the climate-change problem, we draw on Kurunmäki et al. (2016)'s framework – the "triptych" of quantifying, economizing and marketizing – to explain the emergence of a new calculative infrastructure around the notion of climate risk. In many other domains of contemporary management, numbers are being mobilized to play a role in the organization of multiple, or conflicting logics (Carlsson-Wall et al., 2016) and values (Kurunmäki et al., 2016). The framework helps us conceptualize the various stages of formatting climate change as climate risk and suggests that the origins of these numbers are to be found in pre-existing infrastructures and professional enclosures. We shall argue that the processes of quantifying, economizing, and marketizing climate change play a constitutive role in companies' efforts to reconcile the climate-stewardship logic and the logic of the market. This reconciliation goes hand in hand with a performative act of *linguistic cleansing* (Barnhizer, 2013), a language control strategy deployed by adherents of the market logic, to respond to the challenge of the climate-stewardship logic[27] by combining and reformatting the notions of "counting carbon" and "reducing emissions" to "managing climate risk". At stake are the dominant

[27] We thank Keith Robson for directing our attention to this idea.

modes of governance over the climate crisis: which staff functions will carry out the requisite calculations, and what roles should the state, corporations and the "markets" assume in decarbonization?

Empirically, in our case studies we observe the rise of four specific corporate response strategies (Green Transition; Green Segmentation; Defensive; and Engagement Strategies) in different assemblages of technologies – both calculative and production technologies – and sectors. We argue that the responses emerge and co-evolve with the assemblages of aspirations, alliances and artefacts that they are necessarily part of.

This paper is structured as follows: The next section discusses the notion of institutional complexity, focusing on the relationship between the market and the climate-stewardship logics, and institutional scholarship on the variation in the strategic responses organizations give to multiple simultaneous institutional logics. As changes in (ac)counting technologies are among the expected responses to plural logics, we then focus on the roles that seemingly mundane quantification attempts play in the organization of plurality. We'll hone in on the quantification of climate change, and argue that the idea of climate risk is a manifestation of the triptych of quantifying, economizing, and marketizing (Kurunmäki et al., 2016), as it reformats the pre-existing notion of catastrophic physical climate threats into market ideas of economic opportunity and manageable risks. After a brief outline of our research method, we present our findings. We discuss a variety of corporate strategic responses shaped by the resulting quantification instruments, and show the assemblages they form with pre-existing calculative infrastructures, expert groups, their heterogeneous aspirations, alliances, and organizational technologies. In the discussion, we further develop the notion of climate risk as linguistic cleansing via quantification and theorize about the antecedents and politics of co-constitutive accounting and risk management practices and assemblages that facilitate (and are facilitated by) the observed corporate strategic responses. Finally, we summarize our contribution and conclude with directions for future research.

## 4.2 Climate risk and institutional complexity

*Institutional complexity*

Institutional theory conceptualizes stakeholders' varying expectations, interests, and demands through the notion of institutional logics (Friedland & Alford, 1991; Thornton & Ocasio, 2008)— or overarching principles that "prescribe what constitutes legitimate behavior" and provide "taken-for-granted conceptions of what goals are appropriate and what means are legitimate to achieve these goals" (Pache & Santos, 2013, p. 973). Organizations are typically confronted with multiple institutional logics. Health care organizations, for example, find both medical and economic logics at play, with the former emphasizing patient care and the latter prioritizing efficiency (Kurunmäki et al., 2016; Reay & Hinings, 2009). The plurality of institutional logics – and the values behind them – is not always problematic (Carlsson-Wall et al., 2016), but it may become so when the prescriptions stemming from them are incompatible. In such fields of "institutional complexity" (Greenwood, Raynard, Kodeih, Micelotta, & Lounsbury, 2011, p. 318), corporations may respond either by *decoupling* (Meyer & Rowan, 1977) or by *hybridizing*—adopting multiple practices to address plural expectations (Battilana & Dorado, 2010; Pache & Santos, 2013). Accounting and its tools play an active part in mediating between conflicting institutional demands (Briers & Chua, 2001) while, in this process, accounting also hybridizes itself by incorporating logics from other worlds (Miller, Kurunmäki, & O'Leary, 2008).

The institutional complexity of the climate-risk–response field arises from the competing institutional pressures bearing on carbon-intensive firms. Corporations try to remain profit-focused and maintain short-term economic advantages, but also claim to be “prosocial” (Henderson & Serafeim, 2020) and enact climate stewardship. To the extent climate stewardship comes at the expense of profits (Henderson & Ramanna, 2015), fall-outs follow, as illustrated by the recent woes of the multinational food giant Danone, which struggles to please both its investors and its climate-conscious constituents (van Gansbeke, 2021).

**Table 4.1: Ideal Types of Market and Climate-stewardship Logics**

| | Market logic | Climate-stewardship logic |
|---|---|---|
| Goal | Generate profits; maintain efficiency | Limit global warming |
| Means | Activities that maximize revenues while minimizing costs. | Policy measures and investment in technologies to reduce carbon emissions |
| Rationale | Economic efficiency is essential for survival in competitive markets. | Carbon emission reductions are critical for minimizing adverse impacts of climate change. |
| Dominant mode of governance | Market forces are to coordinate social activity – the injunction is to not govern too much. | Government (policy) intervention is necessary and inevitable in the face of the climate crisis. |

The climate-stewardship logic emphasizes the interconnectedness of social and environmental systems and highlights both the impact and the dependence of human activities on climatic conditions and the natural environment (Gümüsay, Claus, & Amis, 2020; Mitzinneck & Besharov, 2019; York, Hargrave, & Pacheco, 2016). While the climate-stewardship logic has evolved over decades (Ansari et al., 2013), the 2015 Paris Agreement formally established climate-change mitigation as a legitimate—and legally binding—goal for nearly 200 countries. Since then, efforts to reduce carbon emissions have proliferated and, in the business context, challenged a dominant *market logic* of efficiency, profit maximization and reliance on “market forces”. With its emphasis on efficiency, the market logic privileges activities that maximize revenues and minimize costs as legitimate means to achieve profitability. It also comes with an injunction to not govern too much (Kurunmäki et al., 2016), highlighting the efficiency of markets in coordinating social activity. Table 4.1 above summarizes the ideal types of climate-stewardship and market logics.

*Climate stewardship vs. market logic? Strategic responses to institutional complexity*

While the literature acknowledges that organizations are often exposed to multiple and sometimes conflicting—pluralistic—institutional demands (Friedland & Alford, 1991), much of it "makes no systematic predictions about the way organizations respond to such conflict in institutional prescriptions" (Pache & Santos, 2010, p. 455). However, strategy studies show that the multiplicity of institutional models of action offers latitude for organizations to exercise strategic choice (Friedland & Alford, 1991; Whittington, 1992). These choices were addressed by Oliver's (1991) model of strategic responses to institutional demands, which was further developed by Pache and Santos (2010).

Oliver (1991) proposed a typology of five strategic responses that vary from passivity to increasingly active resistance: acquiescence, compromise, avoidance, defiance, and manipulation. This typology provided the theoretical foundation for numerous empirical studies and theoretical extensions (Thornton, 2002; Washington & Zajac, 2005; Zilber, 2002). We draw on it to postulate and elaborate on five strategic responses to climate-change–response demands.

*Acquiescence* includes adherence to institutional demands, either by conscious compliance or by unconscious mimicry. Complying with decarbonization imperatives – while also maximizing short-term shareholder value, subject to emissions-reduction constraints – is thus one possible strategic response to climate risk. When organizations consider acquiescence unpalatable or unworkable, they may adopt strategies of *compromise* in order to balance, pacify, or bargain with external referents about institutional expectations. Compromise tactics addressing the climate-change problem may include partial conformity with expectations, compliance with the minimum standards, and less-ambitious decarbonization (and/or compromised shareholder-value-creation) goals. *Avoidance* is an organizational attempt to preclude the necessity to conform by concealing nonconformity or by escaping from expectations. As a climate-change response, avoidance may involve nondisclosure of climate performance, replacement of some—but not all—carbon-intensive production by low-carbon technologies, or alignment with investors and customers who buffer the organization from institutional pressures for costly decarbonization commitments. *Defiance* is a more active form of resistance to institutional pressures, involving vocally dismissing certain institutional expectations (e.g., climate-change denial), actively challenging the emerging rules and norms (e.g., challenging decarbonization policies), or even attacking and denouncing certain institutional values and the constituents that express them. The history of environmental movements is full of manufacturers who attempted to challenge pollution standards and legislation (or to attack activists and NGOs) on the grounds that the pressures were not "rational" or were hostile to their business or that their own behavior was above reproach (Oliver, 1991; Supran & Oreskes, 2017). *Manipulation*—the attempt to co-opt, capture, or control institutional pressures—is the most active form of resistance. In the climate change world, these are the manipulative, defensive strategies deployed by the "merchants of doubt" on behalf of polluting corporations (as described by Oreskes & Conway, 2010). Manipulation also involves lobbying government regulators for changes in the institutional rules in order to stop the rise of new, conflicting institutional demands (such as net zero targets).

Firms may also eliminate the tension by separation or segmenting (Anderson-Gough, Edgley, Robson, & Sharma, 2021; Pache & Santos, 2013)—creating separate subunits to deal with different logics—or by blending logics and creating entirely new management objects (Polzer, Meyer, Höllerer, & Seiwald, 2016). In the case of climate-response, we see the proliferation of corporate sustainability functions, filled with sustainability professionals (Balch, 2021). In other words, new professional enclosures are being created inside organizations tasked with making sense of growing climate-stewardship demands – and respond to urgent institutional calls for corporations to voluntarily disclose their climate risks. Whether the rise of sustainability functions represents an example of separation – or even decoupling – or blending (the creation of hybrid managerial practices) requires further empirical scrutiny.

*Climate risk as linguistic cleansing*

We consider the rise of the "climate risk" concept as another product of this institutional complexity. "Climate risk" is a signifier of a new managerial object that blends the logic of the market and that of climate stewardship. The notion of "climate risk" is a recent construction, engendered by the Financial Stability Board, which set up a Taskforce for Climate-Related Financial Disclosure (TCFD) in 2015, in response to growing societal concerns with climate change. Fundamentally, the TCFD considers risk as exogenous to firms. The taskforce defines two classes of climate risk: "physical" and "transition" risks (TCFD, 2017b). The former includes acute (one-off extreme-weather events) and chronic (sustained, long-term effects) risks that can cause harm to the assets and business prospects of a corporation. The latter includes regulatory (i.e., policy and legal) restrictions, technology (i.e., disruption by "clean tech"), market and reputation risk that can collectively prevent an organization from achieving its objectives. These definitions – at the level of language – blend the societal concern with climate as a physical, destructive and potentially catastrophic force with a more corporate-centric concern with profit prospects in the wake of potentially anti-business and competitive responses to the climate crisis that are outside the control of individual organizations. The TCFD further suggests that companies should consider not only threats, but opportunities too, arising from the need to solve the climate problem. This particular formatting of climate change as climate risk is an example of *linguistic cleansing* (Barnhizer, 2013), a language control strategy deployed by adherents of the market logic, to respond to the challenge of the climate-stewardship logic. According to legal scholar David Barnhizer (2013), the real aim of linguistic cleansing is “the privatization of speech control”, in our case, to control perceptions of the climate change problem, and to gain power over the climate-change discourse. Accordingly, language cleansing involves the shaping of the moral, management and ideological imperatives surrounding the climate change problem.

First, the TCFD definition of climate risk externalizes climate change as a risk to corporations, and thereby deflates attention to the responsibility of these very corporations in collectively bringing about the world’s climate-change predicament. Second, this externalization of risk also suggests that climate change is a manageable problem – and even, an opportunity awaiting exploitation – by corporations. Specifically, the TCFD recommendations are structured around four areas that are argued to “represent core elements of how organizations operate—governance, strategy, risk management, and metrics and targets” (TCFD, 2017b, p. 13). In addition to the general recommendations applicable to all sectors, the TCFD has issued supplemental guidance for organizations operating in specific financial and non-financial sectors (TCFD, 2017a). The formatting of “climate change” as “climate risk”, complete with management guidelines, thus suggests that a new management object has been born, manageable within a firm’s pre-existing corporate governance and financial-disclosure practices, strategy and risk management frameworks. Thirdly, the formatting also implies the taskforce’s preferred mode of governance (Kurunmäki et al., 2016) over the climate crisis: that of the market. As Michael Bloomberg insisted on behalf of the TCFD to the chairman of the Financial Stability Board, “I believe in the power of transparency to spur action on climate change *through market forces*. The Task Force remains committed to market transparency and stability” (TCFD, 2019, p. 1). The injunction to governments (and citizens) is to not govern too much (Kurunmäki et al., 2016), as “market forces” – in the presence of companies’ reliable and relevant climate risk disclosures – are capable of coordinating requisite activity to engender an orderly, smooth transition to a greener economy.

*The antecedents of strategic responses to institutional complexity*

How do corporations respond to such institutional complexity? Pache and Santos (2010) extended Oliver's (1991) original model by identifying the conditions in which specific response strategies are enacted. They postulated that two factors—the nature of the conflict and the intraorganizational representations of that conflict—predict organizational responses to institutional pluralism. While the nature of the conflict addresses the flexibility and negotiability of means and ends imposed on the organization by various stakeholders, internal representation is an outcome of hiring practices—that is, the internal staff groups who enact multiple institutional demands.

Pache and Santos (2010) are silent, however, about the role of nonhuman actors representing institutional demands; that is, the calculative and accounting practices and the risk representations that have been shown to mediate between colliding worlds, logics and values (Briers & Chua, 2001; Chenhall, Hall, & Smith, 2013; Mennicken & Power, 2015; Mikes & Morhart, 2017). Prior accounting research has found that accounting practices can serve as a medium for negotiating—and potentially reconciling—different institutional logics (e.g. Ezzamel, Robson, & Stapleton, 2012; Järvinen, 2016). This is because accounting practices both symbolize and engender institutional logics by representing the organizational goals considered legitimate and the means for achieving them (Pache & Santos, 2013). In situations of institutional complexity, accounting may forge "compromises" and act as a "catalyst" in creating settlements between competing institutional logics (Carlsson-Wall et al., 2016; Chenhall et al., 2013).

Combining different institutional logics and different metrics within accounting tools may bring about such settlements in climate-risk discussions, too. For example, financial journalists and analysts created a carbon-intensity metric, expressing the carbon cost of a firm's operations as a percentage of its EBITDA (Houlder & Livsey, 2021). The metric varies depending on which carbon price is used for its calculation, but carbon-intensity measured at (say) EUR 25 can easily be calibrated to express that intensity at (say) EUR 100 (four times higher), closer to the carbon price economists hold as effective for intensive decarbonization (Houlder & Livsey, 2021). In the process, accounting hybridizes itself by incorporating "logics" from other worlds (Miller et al., 2008), such as emissions-measurement and carbon-pricing practices.

Inside organizations, we have no evidence yet of the potential connections and blending practices that may bring together and fuse carbon-accounting and climate risk management (i.e. emissions scenarios) with more traditional accounting practices such as budgeting and performance measurement. In our study, we therefore pay close attention to the encounters between carbon and climate-risk-related practices and pre-existing calculative technologies. Due to its sheer scale and scope, contemporary accounting has been dubbed as "the most powerful system of representation for social and economic life today" (Miller & Power, 2013, p. 558), increasingly providing the dominant narrative to managing and organizing in particular ways, especially under the dictates of the market logic, with its emphasis on efficiency, competition and value for money. Accounting defined broadly as calculative practices – ranging from budgeting to carbon accounting – allows accountants and others – policy-makers and sustainability experts in our case – to describe and act on entities as high or low-emitters, products as carbon-intensive or "green", and on processes and assets as "climate-saving" or "climate-forcing". To understand what gives accounting this productive force, we need to consider the triptych of quantification, economization and marketization that increasingly characterize the calculative infrastructures in the climate discourse inside and outside organizations.

## 4.3 Quantifying, economizing and marketizing climate change

Recent institutional developments suggest that a synthesis is emerging in the normative literature: practitioners are beginning to see *climate change as climate risk*. We propose that these developments represent the interlocking quantification, marketization and economization (Kurunmäki et al., 2016) of the climate change problematic, whereby numbers, particularly those expressed in economic or financial terms, are increasingly mobilized by actors promoting different responses to the climate change problematic. At stake is the dominant mode of governance to be exercised over the climate crisis, as well as the role of business organizations vis a vis the state and (supra-)governmental actors. While scientists call on governments to engender system-level change (IPCC, 2021) in order to combat the climate crisis, many non-state actors, such as the TCFD put their faith in the ability of the markets to coordinate appropriate and "efficient" responses. Carbon-intensive corporations are caught between these alternative modes of governance– some able to enact decarbonization objectives, others manage to deflect pressures, while others feel doomed without governmental assistance. All of these strategic responses are enabled by new processes of quantification: that of climate change.

*Quantifying climate change: Climate change as a physical threat*

Geoscientists have developed an increasing array of quantification to express the physical threat posed by anthropogenic climate change on human and non-human habitats. Scientific warnings of drastic biophysical changes triggered by rising global mean surface temperatures are abound (IPCC, 2018, IPCC, 2021), and have produced a host of numbers that objectify and support these claims. Scenario analyses now relate various human-induced emissions-levels (or "emissions paths") to an assortment of impact measures as diverse as long-term mean atmospheric temperature rise, sea-level rise, the projected degradation of soil and the rising frequency of extreme weather occurrences in various geographies.

Actors in both climate adaptation and mitigation studies have been shown to rely on an emerging quantitative infrastructure that has expanded to count, monitor and compare carbon emissions at various levels of analysis, ranging from nations, to individual organizations, and even products groups (Ascui & Lovell, 2011). The stage is thus set for the next movement in the drama of quantification – one that endows these emission numbers with economic significance (Kurunmäki et al., 2016); and with that a truly productive, evaluative and subjectivising force (Miller & Power, 2013).

*Economizing climate change: Climate change as opportunity*

By economizing, Kurunmäki et al. (2016, p. 395) mean “the ideas and instruments through which individuals, activities, organizations, nation states, regions, projects and much else besides are constituted as economic actors and entities” (see also Miller & Power, 2013). Economizing climate change denotes the tools by which this geoscientific entity is getting formatted into an economic opportunity (or cost) for nations states and organizations. It is important because environmental studies have shown that managerial attention is guided by the framing of environmental issues as profitable or non-profitable, which affects firms’ abilities to enact proactive response strategies, as they prioritize what is deemed as profitable. Sharma and Vredenburg (1998) found that oil and gas companies that perceive environmental responsiveness as fundamental to increasing shareholder value deploy proactive strategies, while those that see it as separate from or even conflicting with shareholder value creation are more reactive (Hart, 1995; Hart & Dowell, 2011).

According to the natural-resource–based theory of the firm (Hart, 1995)[28], firms with capabilities that facilitate environmentally sustainable economic activity—such as the prevention of emissions and waste—are likely to have a competitive advantage over their peers. Yet, in practice, the question of whether it pays to be green (and whether it pays for firms to decarbonize) has not been conclusively settled; the literature still calls for the identification of the contingencies (Berchicci & King, 2007) and of the resources and capabilities that affect a firm's environmental-financial–performance relationship (Hart & Dowell, 2011). For example, Henderson and Serafeim (2020) argue that decarbonization is a grand challenge (Wright & Nyberg, 2017) that requires a host of complementary innovations and close engagement with governments and policymakers. Even with a strong business case, such systemic innovation is difficult. The authors hypothesize that "purpose-driven firms" (defined as those actively embracing a social purpose beyond profit maximization) are much more likely to enact proactive decarbonization strategies "to drive the kind of transformative innovation that is essential if we are to tackle climate change" (Henderson & Serafeim, 2020, p. 179). Such a commitment is unlikely to create profit by itself, but in combination with strong innovation capabilities—particularly those related to continuous improvement (King & Lenox, 2002)—profit may be derived (Christmann, 2000).

*Marketizing climate change*

The idea that markets can solve the climate problematic is deeply rooted in neoclassical economics and neoliberal ideologies that extend the rationality of the market to an increasing array of social domains (Bailey et al., 2011; Boyd et al., 2011; Sandel, 2012). Accordingly, carbon markets have been created in the last two decades for the trading of emissions rights (Knox-Hayes, 2016, 2018), as well as to enable investment in

[28] Such economic theories themselves can be taken as forms of economizing.

sustainability-conscious firms, intent on climate stewardship. Carbon markets do not operate on their own, they are constituted by a complex web of regulatory, public, and private actors (Knox-Hayes, 2010). The questions at stake are, to what extent will these markets operate under the influence of public versus private actors and under what governance principles? Currently, carbon markets are supervised by the state, or – as in the case of the EU – by supranational actors, upholding a concern with decarbonization. The EU has one of the world's most ambitious climate-change policy frameworks. The central policy instrument is the EU Emission Trading System (ETS), the world's first and largest international carbon market. The ETS applies a "cap and trade" principle that sets a limit (cap) on the total amount of carbon dioxide[29] that can be emitted in the EU. Within this limit, companies either receive or buy emission allowances, each granting the right to emit one metric ton of carbon. The allowed amount decreases over time (as a matter of policy decisions made by the EU), which constrains the supply and increases the price of emission allowances, making it increasingly expensive for companies to buy them to cover their carbon emissions. The price of emission allowances (from here on, "carbon price") has risen from €8 in early 2018 to almost €90 in December 2021. With the marketization of climate change, what is at stake is the power over the governance of these markets – and, in the name of the market logic, a potential transformation towards a more self-governing market, in which "market forces" (not state actors) determine the amount and extent of decarbonization, as dictated by the "rationality" of actors, buying and selling emission rights and shares in higher / lower emitting firms.

[29] In addition to carbon dioxide ($CO_2$), the EU ETS covers nitrous oxide ($N_2O$) and perfluorocarbons (PFCs). Since the latter two greenhouse gases are less relevant in our research setting, we focus on carbon dioxide emissions, refering to them simply as carbon emissions.

*Climate change as organizational risk*

Over the last decade inside corporations, too, climate change has been reframed as a "risk issue"—climate risk—which could be absorbed into existing risk management processes (Pinkse & Gasbarro, 2019). For example, the 11 utilities studied by Weinhofer and Busch (2013) framed climate change as a risk—defining it as "all potential negative impacts on business activities caused by the physical effects of climate change" (Weinhofer & Busch, 2013, p. 122)—amenable to the thermostatic control process of identification, assessment, and mitigation/transfer. Such studies define climate risk as exogenous to the firm but capable of being dealt with by managerial (adaptive) interventions (Winn, Kirchgeorg, Griffiths, Linnenluecke, & Günther, 2011) in industries ranging from public water supply (Arnell & Delaney, 2006) to agriculture (Kandlikar & Risbey, 2000) to tourism (Scott, McBoyle, Minogue, & Mills, 2006).

Bui and Villiers (2017) further underline the role of risk management systems in framing climate change as a risk issue. However, in their study of the changing climate-response strategies of five New Zealand electricity generators, they attributed an observed strategy change—from anticipatory, proactive, creative decarbonization strategies to reactive approaches—to a significant regulatory uncertainty, which these companies, via their risk management processes, framed as rising risk and disappearing opportunities. By the end of 2010, all their carbon-neutrality programs had been discontinued and, although the companies "still pursued a green brand, they no longer '*considered carbon neutrality as essential to the green image*'" (Bui & Villiers, 2017, p. 16, emphasis in the original). Although Bui and Villiers (2017) highlighted the role of risk management practices mediating between corporate climate risk perceptions and (in)action on climate change, the actual processes, tools, and expertise at work still constitute a black box (O'Dwyer & Unerman, 2020).

Yet how climate change is framed inside that black box—and "what strategic actions they [companies] take to manage and mitigate those risks"—matters (Flammer et al., 2021, p. 3). In an exploratory study of 18 listed Australian companies, Kumarasiri and Gunasekarage (2017) found that corporate action on curbing carbon emissions was primarily driven by perceptions that the regulatory and community pressures around climate change were threats rather than opportunities. However, the perception of climate-related pressures differed between companies in industries with high and low carbon emissions, indicating that industrial carbon emission profiles shaped companies' climate-risk perceptions. Whereas low-carbon companies understood climate change primarily as a reputational risk driven by community pressures, carbon-intensive companies perceived it as a direct financial threat emanating from carbon taxes imposed by the Australian government in 2012 (and repealed in 2014). These differentiated climate-risk perceptions affected companies' use of management accounting techniques to monitor and manage carbon emissions, with carbon-intensive companies more likely to set carbon-emission–related targets and implement performance measurement systems for tracking energy use and carbon emissions (Kumarasiri & Gunasekarage, 2017).

Despite this emerging empirical literature (primarily documenting cases in Australia and New Zealand and the energy sector), there is still a need for contemporary accounts from a diversity of industries of the most impactful institutional contexts and the most impacted corporations.

Although research acknowledges *the importance of climate-risk perceptions* as part of the cognitive antecedents of corporate response strategies (Haney, 2017; Hoffman, 2005; Kolk & Pinkse, 2005; Mazutis & Eckardt, 2017; Todaro, Testa, Daddi, & Iraldo, 2021), little is known about how these perceptions are formed and mediated by particular organizational processes, tools, and expertise—what goes on in the black box? The most recent assessments of the state of play suggest that climate change requires systemic innovations that most likely require companies to engage in redefining the "rules of the game," including the (external) policy frameworks and evaluative institutions that determine the appropriateness and feasibility of decarbonization strategies (Henderson & Serafeim, 2020). Companies have to address the multiple institutional demands inherent in the problem of climate change – and our interest is to show how they draw on the notion of climate risk (and its ongoing quantification, economization and marketization) in order to do that.

## 4.4 Methodology

We conducted a multiple case study of 19 publicly listed European companies in the chemical, steel, and utilities industries. Due to their high–carbon-emission operations, these industries are particularly exposed to institutional demands for substantial reductions. However, such reduction is particularly challenging for them, as their business models have long relied on cheap fossil fuels. We therefore considered this a pertinent setting in which to investigate how companies navigate simultaneous institutional demands for decarbonization and profit.

These three industries are part of the Industry and the Electricity & Heat Production sectors, which account for almost 50 percent of anthropogenic greenhouse gas emissions (IPCC, 2014b). The steel industry alone is responsible for around eight to nine percent of global carbon emissions and each ton of steel produced in 2018 generated on average 1.85 tons of carbon emissions (World Steel Association, 2020). While modifications of conventional production processes can yield moderate emission reductions, decarbonizing the steel sector in line with the Paris Agreement will require deploying novel breakthrough technologies at industrial scale (Energy Transitions Commission, 2018a). While several technological pathways for low-carbon steel production exist, they are considerably more expensive than conventional processes (Hoffman, van Hoey, & Zeumer, 2020).

European steel companies thus face a conundrum: Within the EU ETS, steel companies have long received free emission allowances. As part of the EU's ambitious climate policies, these free allocations have been cut back, increasing the number of allowances steel companies need to buy—at ever-higher prices—in auctions or on secondary markets. Both factors increase the cost of steel production, but so would the implementation of expensive low-carbon production technologies. Finally, it is hard for European steel companies to pass on higher production costs to customers, since they compete in global commodity markets.

The chemical industry in Europe is exposed to similar dynamics, but with structural differences. For our purpose, it is sufficient to highlight two of them. First, there is a large variety of chemical products that are manufactured with various technologies. Depending on the product, chemical manufacturing can be more or less carbon-intensive and more than 60 percent of the sector's total direct carbon emissions is generated in the production of a relatively small number of primary chemicals (e.g., N-fertilizer ammonia alone accounts for 30 percent of sector emissions) (Energy Transitions Commission, 2018b). Secondly, chemical products are sold into a large number of markets, some willing to pay premiums for differentiated products. So while the chemical sector is exposed to the same institutional demands for decarbonization as the steel industry, the contextual factors (carbon intensity, availability of low-carbon technology, ability to pass on costs to consumers) are more heterogeneous and contingent upon a given company's positioning in chemical value chains.

The utilities industry's exposure to institutional demands for decarbonization is similar to those of the chemical and steel industries, but utilities do not get free EU emission allowances. As a result, their exposure to high carbon prices is greater than that of the chemical and steel industries. On the other hand, low-carbon technologies for electricity generation are widely available at competitive costs. For example, the costs for utility-scale solar installations declined by 82 percent in the period of 2010–2019 and the cost of 56 percent of all newly commissioned utility-scale renewable power generation capacity in 2019 was lower than that of the cheapest fossil-fuel–fired option (IRENA, 2020). Similarly, the ability of utilities to pass on costs to consumers tends to be higher than those of steel and chemical companies. Finally, the carbon-intensity of operations in the utilities industry depends on a company's business model (e.g., percentage of energy generation using fossil fuels).

In sum, the industries in our research setting are exposed to the same institutional demand for decarbonization but their specific exposure is contingent on contextual factors (see Table 4.2). By holding the institutional demands for decarbonization constant, this research setting allows us to investigate the antecedents of companies' strategic responses.

**Table 4.2: Industry Context**

| | Steel | Chemical | Utilities |
|---|---|---|---|
| Exposure to institutional demands for decarbonization | High | High | High |
| Carbon-intensity of operations | High | Moderate to high | Low to high |
| Ability to pass on costs to customers | Low | Low to moderate | Moderate to high |

Our *case selection* was guided by two criteria. First, we decided to select cases from a population of publicly listed companies with headquarters in member states of the European Union. Establishing a level institutional playing field—in terms of both regulatory environment and corporate governance—allowed us to limit extraneous variation (Eisenhardt, 1989). This is particularly relevant when examining corporate responses to climate change, since regulatory designs such as the European Union Emission Trading Scheme are important contextual factors of corporate climate action (Bui & Villiers, 2017; Slawinski et al., 2017). Likewise, corporate governance variables, such as ownership, can significantly influence environmental strategies (Calza et al., 2016); and publicly listed companies face similar institutional constraints through their exposure to capital markets. Second, we chose companies at different positions in the value chains of their industries. In the chemical and steel industries, we selected companies with portfolios ranging from commodity to speciality products, the latter generally having higher margins and lower carbon footprints. Likewise, we chose companies with different business models from the utility industry to introduce variation in both economics and carbon footprints (e.g., power generation portfolios with different proportions of fossil-fuel and renewable energy). Table 4.4 in the Appendix provides an overview of the 19 companies in our case study.

Our research drew on two *data sources*: semi-structured interviews and archival documents. Between May 2019 and November 2020, we conducted 21 semi-structured interviews with the designated sustainability managers from the 19 companies in our sample, each interview lasting between 40 and 80 minutes. In some cases, the sustainability agenda was delegated to, or shared by, a member of the finance, strategy, technology or the risk management function (see Table 4.4 in Appendix), thus five interviews involved multiple participants (Steel 1, Steel 3, Utility 3, Utility 6, and Utility 8) and in two cases (Chemical 1, Utility 1) different participants from the same company were interviewed separately. With the exception of four interviews in which the participants declined to be recorded (extensive notes were taken), each interview was audiotaped and transcribed. Drawing on an interview guideline, participants were asked about their role, how climate risk features in their responsibilities, the organizational functions involved in managing climate risks, the practices in place for assessing climate risks, the organizational processes informed by these assessments, and the company's responses to climate risks. In February 2021, we conducted six face-to-face (online) follow-up interviews (Chemical 3, Steel 2, Steel 3, Steel 5, Utility 1, and Utility 2) to follow up on developments and ascertain the accuracy of our first-round findings. All follow-up interviews were recorded and transcribed. To complement and triangulate the interview data, we collected annual reports, sustainability reports, and responses to the 2019 CDP[30] Climate Change Questionnaire. Since 2018, the questionnaire has incorporated questions on the recommendations of the Task Force on Climate-Related Financial Disclosure, structured around governance, strategy, risk management, and metrics and targets (TCFD, 2017b). Responses to the CDP questionnaire were thus particularly useful in verifying and complementing interview data on the climate-risk tools and metrics used by case companies, as well as on the climate-risk-related opportunities and threats they disclosed. We further reviewed annual and sustainability reports to gain a deeper understanding of business models, strategies, and how companies perceived their business environment.

We conducted a comparative case study of our 19 sample companies, following a four-stage abductive approach to data analysis. We used the QSR Nvivo software to build a case database to combine data from different sources in a central repository and facilitate the data processing and analysis. In the first stage, we combined interview transcripts, corporate reports, and CDP responses to construct individual case studies of our sample companies. The second stage involved a detailed within-case analysis of this subset of cases to cluster information that addressed primary questions such as what, why, who, how, and when (Lofland, 1976). Starting with an analysis of interview transcripts, this clustering allowed us to identify emergent themes in the interviewees' comments without introducing premature analytical biases (Battilana & Dorado, 2010, p. 1421). In particular, we noted our interviewees' professional backgrounds and experiences (who), the diverse ways in which they described climate risks (what), how and with whom they

[30] CDP is a nonprofit organization that operates a corporate environmental disclosure system and gathers data on corporate action on climate change. The dataset was purchased with funding from Said Business School.

discussed these risks at work, why these particular risks entered their agendas, and what actions were taken in response and when. We subsequently triangulated the interviewees' accounts with corporate disclosures (annual and sustainability reports) and CDP responses. Based on our research question, three major categories of codes were used at this analytical stage: (a) climate-risk perceptions (what was identified as a climate risk; threat or opportunity); (b) climate-risk management practices (which tools, processes, and functions were involved in identifying and assessing climate risks); and (c) climate-risk response (which actions were taken).

In the third stage, we moved from within-case analysis to cross-case analysis, using techniques proposed by Eisenhardt (1989) and Miles and Huberman (1994). In particular, we used tables and matrices as analytical devices to identify patterns of similarities and differences among cases (Cloutier & Ravasi, 2021). During this stage, we realized that the climate-risk perceptions emerging from our data reflected companies' entanglement in complex webs of institutional expectations, to which they responded differently (an inductive step). Iteratively going back and forth between our data and extant theory, we found Oliver's (1991) framework of strategic responses to institutional processes and its extension by Pache and Santos (2010) helpful for understanding the emerging patterns in our data (a deductive step). The fourth stage of our analysis applied these preliminary findings to the full set of case studies, which confirmed the validity of our associations. Finally, we carried out follow-up interviews with six companies to check what had changed in their perceptions of and responses to climate risk since the initial interviews. These interviews confirmed that the associations we observed in our data were stable; we therefore concluded that we had reached saturation.

## 4.5 Strategic Responses to Climate Risks

This section will take a closer look at companies' strategic responses, with a particular emphasis on operational and externally oriented actions. We find that strategic responses form patterns in different assemblages of heterogeneous aspirations, alliances and calculative artefacts (Kurunmäki et al., 2016), and we develop a typology to distinguish four types: Green Transition, Green Segmentation, Defensive, and Engagement Strategies. We illustrate each archetype with a representative vignette from our case database.

*Green Transition Strategy*

We classified five companies in the sample as enacting this strategy. They explicitly aligned their business models with institutional demands for decarbonization by aspiring to deliver low-carbon products through their core businesses and significantly reducing carbon emissions in their own operations. To support their positioning as providers of "climate solutions", they leveraged calculative practices to demonstrate the climate benefits of their products and publicly advocated for ambitious climate action.

*Illustrative Case: Utility 3*

Utility 3 was undertaking a significant restructuring, divesting from its coal- and gas-fired power plants and focusing on energy transmission, energy distribution, and customer services (e.g., energy efficiency programs, electromobility infrastructure). This reorientation was motivated by a strategic rationale to take advantage of the emerging "new energy world" characterized by decarbonized, decentralized, and digitized energy systems. With its new business model focused on "delivering our customers' climate protection agenda," the company aimed at full goal congruence of its decarbonizing and financial objectives.

Utility 3's alignment with an ambitious climate change agenda was also reflected in its targets to achieve a 75-percent carbon-emission reduction in its own operations by 2030 (base year: 2019) and be fully decarbonized by 2040. Given its strategic focus on delivering climate solutions, the company also pledged to reduce its customers' carbon emissions by 50 percent by 2030.

Utility 3 made extensive use of scenario analyses to evaluate the implications of various climate-related scenarios for its strategic position and investments. The application of carbon prices was an important element in these analyses and "influenced our strategy to sell the full portfolio of fossil fuel power plants" (Utility 3, CDP Response 2019). Conducting the analyses involved the close collaboration of the company's sustainability and strategy functions. In addition to infusing sustainability expertise into strategy processes, Utility 3 also integrated climate risks into its risk-management processes. While the climate-risk assessments were initially developed and managed by the sustainability function, as of 2021, the risk function took over responsibility for climate risks, advancing the hybridization of accounting and risk management practices by climate change expertise.

Overall, Utility 3's strategic response to climate risks was characterized by an understanding that the "opportunities on our side are greater than the risks" (Utility 3, IP19). While completing its strategic repositioning as a provider of climate-friendly solutions, Utility 3 also lobbied for the introduction of a €35-per-ton carbon tax in addition to the EU Emission Trading Scheme. This was motivated not by a sense of moral duty but by a rational, self-interested calculation: a higher financial penalty on carbon emissions would increase the demand for Utility 3's low-carbon solutions.

*Green Segmentation*

We classified seven companies in the sample as enacting this strategy, which focused on greening business models in specific low-carbon product segments. The business models of companies enacting Green Segmentation were not fully aligned with institutional demands for decarbonization, as those of companies enacting Green Transition Strategies were. These companies did, however, engage in externally oriented work to increase the sales of products with self-certified environmental and climate benefits.

*Illustrative Case: Chemical 1*

Chemical 1 aimed to refocus its business on “sustainable solutions: products demonstrating lower environmental impact during [the] production phase and an enhanced social and environmental contribution along the value chain.” This wording echoes the stewardship logic: the company internally defines and designates products as “solutions”; that is, products “that we consider to have a positive impact on the planet.” These are also “high-margin materials,” which the business strategy prioritizes.

However, the company’s green transformation was far from complete. It aimed to have 63 percent of its portfolio sustainable by 2030, implying that it was prepared to keep over one-third of its product portfolio emission-intensive. The company’s decarbonization target was in line with the Paris Agreement (“well below two degrees”) but not in line with the more ambitious scientific targets seeking the 1.5-degree scenario.

The company incentivized business units to come up with their own ideas for sustainable projects and deployed resources for proposals that passed its internal test, a “sustainability screen” to assess environmental and climate change impacts. High carbon prices were used in project and investment appraisals, ensuring that carbon-intensive proposals carried a significant cost of the negative externalities they imposed, “especially in China, Brazil, and America,” where the market carbon price was zero at the time. This allowed innovative technologies (such as “lightweighting auto and aircraft”) and renewable energy proposals to be prioritized. However, the use of EUR50 as a carbon price, a figure intended to incentivize innovation and decarbonization efforts, was still well below the USD 100 carbon price promoted as more effective (and possibly the market price by 2030), suggesting that Chemical 1 intended to keep a non-green portfolio segment.

In this way, the company reached partial (though significant) compliance with the decarbonization purpose, while also keeping a significant portion of the "old business," thus meeting short-term demands for cash-flow growth. Notably, Chemical 1's ability to differentiate with green strategies and pass the cost on to customers enabled it to do without government subsidies; we found no evidence for lobbying. The breakthrough technologies for its carbon-light projects (renewables for electricity generation, lightweighting solutions for transport) were considered as given or imminent.

Accounting and marketing tools were hybridized by sustainability expertise and, in turn, the sustainability function was hybridized by operational expertise, enhancing its relevance to the business. The structural positioning of the sustainability function within the CFO department further enhanced the sense of goal congruence between the two institutional demands, which the company was able to partially reconcile by its own strategic initiative—that is, by producing, within the limitations of the industry structure, profitable solutions for customers that were also good for the planet. However, the company could not extend these solutions to its entire portfolio, nor could it commit to science-based targets. It remains to be seen if Chemical 1's own self-certified green products and partial decarbonization strategy will suffice to maintain long-term differentiation.

*From Defensive to Engagement Strategies*

In the initial round of interviews, we found only two companies enacting Defensive strategies in the sense that they sought to maintain the status quo while concealing this focus and instead projecting a green façade in their climate-change communications (Supran & Oreskes, 2017). However, one of them (Steel 2) has changed strategy over the last 18 months, taking a deliberate turn towards active Engagement with institutional referents in order to facilitate compromises on conflicting demands and to bargain with them over the expectations and conditions of a decarbonization pathway. The other company, Utility

1, was planning—according to our latest interview with its senior sustainability manager—to follow suit and considers it a "maturity issue": given its recent takeover by a more sustainability-oriented group, the company would have to engage more with stakeholders. We illustrate the shift from Defensive to Engagement strategies through the case of Steel 2.

*Illustrative Case: Steel 2*

According to its Head of Sustainability, Steel 2 represented the profit-oriented market logic: "[Steel 2] was not set up to help solve climate change. It was set up to run a business. […] [T]he business has to be successful in the context of a climate-challenged world" (Steel 2, IP10).

The company's own calculations indicated that "there is no viable technology that can decarbonize steelmaking" and this was the narrative the company projected to the outside world, until 2021. Steel 2's initial defensive stance was also evident in its framing of climate risk as an important reputational issue, emphasizing the "need to be seen to be taking it seriously": "Our biggest risk, I would say, is stakeholders thinking we're not doing enough […] I think what turned the switch on whether we should do a TCFD report—we need to be seen to be responding to these expectations, these recommendations. We need to be seen to be taking it seriously" (Steel 2, IP10).

Yet outside of power generation, the steel sector is the largest industrial producer of greenhouse gases. Steel, made from iron ore at extreme heat and using coal both as a source of energy and as a processing material, is especially hard to decarbonize. As steel is already one of the most reused materials on earth, no amount of efficiency gains in recycling could ensure its decarbonization. What is required is breakthrough technology, potentially costing EUR 15–40 billion by 2050 (Pooler, 2021). European steelmakers generate one ton of $CO_2$ for each ton of steel—half the emission rate of Chinese competitors—yet their relative carbon efficiency does not yield them any competitive advantage, as carbon is not yet priced (taxed). And even if it were, European steelmakers would find themselves at a competitive *dis*advantage, given that the EU (seemingly) lacks the political power or will to impose green border adjustments (which China vehemently opposes as "protectionism"). Hence, European steel companies have relied for many years on their exceptional status in the ETS system.

Thus, at Steel 2, climate risk did not feature much in internal managerial discussions until 2018, when Climate Action 100+, a climate-focussed investor group, challenged the company to respond to climate-related stakeholder expectations. Many internal constituents pointed out that Climate Action 100+ constituted only a small minority of investors and, apart from an agreement to produce TCFD disclosures, not much changed internally. But our interviewee, the head of sustainability reporting, oversaw Steel 2's reporting into the CDP and TCFD frameworks and realized that this external reporting started to "drive internal conversations: We've got to respond to these stakeholder expectations. Let's have a think how we do that." In response to the TCFD's questions about climate risk, the sustainability department engaged with the CFO function and established that the "biggest risk is bad policy."

This reflected the rising awareness of the steel industry's contribution to the climate change problem and of EU policymakers' plans to turbocharge the necessary innovation by making the carbon emission trading scheme bite. This would happen through the gradual phasing out the ETS allowances for steelmakers, which would effectively levy a growing carbon tax on them. Having identified this policy risk, Steel 2's Head of Sustainability was able to grab the attention of the CFO and the Head of Strategy. Internal documents calculated that the sector would need a price over EUR100 a ton to make breakthrough technology viable. But this imposed an existential risk to the current business model, because with steel being a commodity, producers could not pass the increased cost on to customers: "We are not afraid to take steps to decarbonize, but if we have to do it and our competitors don't, we are out of business. […] We can't ask our Government Affairs team to go out and ask [governments] for EUR100 a ton. That would just send shivers down the spine of every stakeholder, every steelmaker. There is a journey you have to go on to get there" (Steel 2, IP10).

This journey included lobbying European regulators to level the playing field across steelmakers by introducing green-border adjustment: "And that's what is happening with the Emissions Trading Scheme in Europe. That's why we are arguing for green border adjustments. […] Our message has to be, 'If you want us to decarbonize, this is what needs to happen'" (Steel 2, IP10). Yet the EU's carbon border levy could face years of delay due to opposition from China and the U.S. (Khan & Fleming, 2020).

Having found itself between a rock and a hard place, Steel 2 faced an existential risk with the continuing phase-out of the ETS scheme. This elevated the issue to the CEO's office and Steel 2 stepped up its policy-oriented work: it aimed to become a "leader" in the policymaking space. Lobbying in Europe—both directly and through the World Steel Association—for a carbon tax and for government subsidies required analysis combining sustainability, operations, and business expertise. Steel 2 now had a full-time analyst undertaking such calculations, producing, for example, "a carbon abatement curve" to show the carbon prices at which lower-carbon products could be viable. Steel 2 was also locating potential customers for higher-margin, low-carbon steel products, introducing its own self-certification of "green steel" and offering it (first) to European automakers who had pledged to science-based targets for decarbonization.

The analyses also investigated various radical technological options for decarbonization and the investment needed to bring them about. Steel 2 sought a voice in the policy space (and in the World Steel Association) to lobby governments to help these innovations—not just the one favored by Steel 2, but also those more suitable to European competitors.

> "The steel industry may in the end be like the IT industry with its operating platforms. We are the equivalent of Microsoft, dominating the industry with very good technology—the blast furnace. Now we are challenged by the appeal of the new "simple" hydrogen DRI technology—Apple. But rather than fighting it and creating a polarity in the industry, we are embracing it and will, in the end I think, maintain both routes. Probably the hydrogen route, like Apple, will be the luxury of rich nations for many decades to come. But the smart circular carbon approach will be regarded as the approach that is more realistic, achievable and, in an expanded system view, more valuable to a net-zero world." (Steel 2, IP10 by email, February 9, 2021).

Here we see a particular style of policy work that no longer serves Steel 2's commercial interests alone, but also those of the whole industry. Steel 2 has taken on the role of an "agent to the system" (Henderson & Ramanna, 2015).

## 4.6 The Conditions of Strategic Responses to Climate Risks

We found that the four strategic responses to climate risks were associated with and shaped by distinct conditions and calculative practices. In line with sectoral and business-model differences, we find that the lack of goal-congruence between the market and climate-stewardship logics was particularly acute for companies controlling predominantly climate-forcing assets; that is, assets associated with substantial carbon emissions (Colgan et al., 2021). In contrast, companies holding climate-saving assets that were less carbon-emission–intensive or that directly facilitated carbon emission reductions experienced less tension between commercial and climate-stewardship logics (Paterson, 2021). Overall, we found that the four response strategies were strategic in the sense that they represented the heterogeneous aspirations and conditions of possibility that these companies were acting on, as they sought to reconcile the plural demands for climate stewardship and profits.

*Green Transition Strategy*. Companies enacting this strategy perceived institutional demands for decarbonization as a significant *opportunity* for commercial success. Utility 8, for example, recognized that the transition to a low-carbon world was its "greatest opportunity" and positioned its business model to capitalize on that opportunity by ramping up renewable-energy generation and adjacent low-carbon services. Companies pursuing the Green Transition Strategy were thus not only committed to reducing carbon emissions in their own operations but focused on "developing solutions to help customers and consumers to cut theirs" (Chemical 2, Annual Report 2019). In line with their perceived high goal congruence, these companies set ambitious decarbonization targets not only for their own operations (Scope 1, 2), but also for the carbon emissions (Scope 3) associated with their supply chains and customers.

To deliver on these objectives and support the marketing of low-carbon solutions, companies leveraged *calculative practices* to measure and market the climate benefits of their products. For example, Chemical 5 developed a "methodology and reporting framework to allow consistent calculation and reporting" of the carbon emissions that are avoided through using the company's products. Through this calculative practice, Chemical 5 was able to market its products as climate solutions that "led to a combined total of 850,500 tonnes $CO_2$ avoided" in 2019 (Chemical 5, Sustainability Report 2019). Furthermore, companies incorporated internal carbon prices into their investment appraisal processes and, in the case of Chemical 2, introduced an internal carbon "penalty" of €50 per ton of carbon in the internal management accounts, modifying the income statements of business units, charging them with carbon-costs. While this charge was only integrated into the internal performance reporting, the company took this step to "increase the awareness and further drive emissions reductions." This was in effect also an attempt at redefining "true profit" (Mayer, 2018), hybridizing accounting by a sustainability-related penalty. Overall, the high congruence of financial and decarbonization goals in companies pursuing the Green Transition Strategy was associated with the integration of climate risks into routine business processes, ranging from investment evaluation and the sales process to performance measurement.

*Green Segmentation Strategy*. This strategy is based on the recognition that there are market-based opportunities afforded by developing “low-carbon” solutions or niches in areas in which customers are willing and able to pay for them, rewarding the high cost of developing these markets. While companies tried to increase the proportion of climate solutions in their portfolio, another significant proportion was legacy business (limited goal congruence). These companies’ efforts to decarbonize focused on their own operations; they did not set decarbonization objectives for their supply chains or customers (Scope 1 and 2 targets only). Internal carbon prices were included in the evaluation (“screening”) of products, investment projects, and M&A targets. On average, companies enacting the Green Segmentation Strategy internalized a carbon price of €58, more than double the average price used in the Green Transition Strategy. The application of carbon prices in investment appraisals was a way to bring climate risks to the attention of business units; here we see the role of (hybridized) accounting as “ammunition” to “lobby” internally for specific ends (Burchell et al., 1980)—green solutions. As the sustainability manager (IP7) at Chemical 6 explained:

> “Because we have defined a $CO_2$ price, they [business units] must now consider in their economic optimization which processes and which pumps make the most sense, and then calculate this with the corresponding $CO_2$ prices. I would say that such a $CO_2$ price makes my life easier, because at the end of the day, the more $CO_2$-intensive the plant is, the more the $CO_2$ price that we apply or that we prescribe affects the profitability.” (Chemical 6, IP7)

Companies also developed hybridized marketing tools for showing salespeople the environmental and climate impact of products. Chemical 1, for example, embedded such results into the customer relationship management system so sales teams could “use the sustainability data we have developed inhouse.” Chemical 1 deployed a hybridized performance measurement dashboard—combining financial, emissions, and other sustainability data—as its “central management reporting device.” The dashboard’s role was mainly to raise awareness of the sustainability angle; performance rewards were not linked to it.

*Engagement Strategy*. Companies enacting this strategy perceived climate risks as transition risks posing a serious, existential *threat*. Mitigating this threat by themselves was deemed impossible in the given policy and market environment without compromising financial viability (low goal congruence). Without access to cost-competitive, low-carbon technologies, companies deemed it impossible to further decarbonize (“with the technologies available today, we are not getting much further down in $CO_2$ emissions”). These companies looked to policy-makers and governments to provide the requisite infrastructure (for example, a hydrogen-fuel grid) and/or subsidies to build part of it themselves. This dialogue (as well as the negotiation of compromises and concessions on their decarbonization path) required policy work and active lobbying. As the sustainability manager at Steel 3 emphasized: “It is difficult political work.”

This was also reflected in decarbonization objectives, which (a) were contingent on new technologies (Steel 1, Steel 4), (b) applied only to specific business units (Steel 2), or (c) were markedly less ambitious than the targets in the Green Transition and Green Segmentation Strategies (Steel 3, Chemical 3). An exception was Steel 5, a speciality steel company with a below-average carbon-intensity; it had set a science-based carbon-emission reduction target consistent with keeping global warming to 2°C.

Companies applied internal carbon prices in investment appraisals to assess the robustness of projects in different political and market scenarios, considering questions such as those outlined by the sustainability manager (IP14) at Steel 4:

> "Will the $CO_2$ price rise? Can one bet on the fact that a global level playing field can be created? Can we assume that the market will at some point be willing to share the transformation costs? So it is also important to look at what the political initiatives are and what possibilities there are for creating framework conditions that will allow an investment decision to be made." (Steel 4, IP14)

Similar questions were also considered in scenario analyses to map out different technology pathways and calculate their feasibility and their investment needs under various policy and market constellations (as shown in the case of Steel 2).

*Defensive Strategies*. Companies enacting these strategies saw climate risks as an existential threat to the business and institutional demands for decarbonizing were perceived to be in direct conflict with commitments to deliver shareholder value. The response to these conflicting demands involved communication tactics to deflect decarbonization pressures and protect the current business model. Climate risks did not feature in managerial discussions.

*Summary*

Overall, we see corporate strategic responses emerging in four patterns that highlight the varying and dynamically evolving assemblages of institutional demands (for climate stewardship and / or profits), corporate aspirations, calculative practices (accounting and risk tools), sustainability and risk experts, and the collective framing of climate change as climate risk (both threats and/or opportunities). In these assemblages, there are different perceptions of the nature of the conflict between climate stewardship and the market logic. Companies whose sustainability experts and / or risk managers frame climate change as a risk entailing "opportunity" perceive a higher goal congruence, enabling managers to expect and search for profitable alternative business models (Green Transition) or products (Green Segmentation). Such framings were reinforced and communicated by new, hybrid accounting practices, emphasizing internal carbon pricing, scenarios and the setting and monitoring of more or less ambitious carbon targets (more ambitious in case of Green Transition). While Green Transition responses were conditional on an entity's access to (or control of) climate-saving assets, technologies and product offerings, Green Segmentation responses were predicated on only partial ownership of such enablers, with climate-forcing technologies and products still remaining a significant feature of the business model.

Engagement Strategies (as they replaced Defensiveness) also drew on accounting as a narrative and applied the reformatting of climate change as climate risk as a way of visualizing the economic consequences (and regulatory or reputational ramifications) of climate inaction. But it was the notion of climate risk, and, in particular, the framing of climate change as an existential threat that drove action – an active engagement with policymakers and other constituents – in search of a compromise as these companies (and others) were abandoning previously defensive strategies. More recently, scenarios and carbon pricing of emissions were used to investigate alternative policy options, both to support technological innovation, infrastructure investments and potential policy choices, to be worked out in collaboration with other industry participants, policy makers and governments, as corporations increasingly sought to rein in their "climate risk". It is these acts of reformatting of climate change as climate risk, via quantification, economization and marketization that we finally turn to in our Discussion.

**Table 4.3: Antecedents of Strategic Responses to Climate Risks**

| | | Green Transition Strategies | Green Segmentation Strategies | Defensive Strategies | Engagement Strategies |
|---|---|---|---|---|---|
| Companies | | Chemical 2, Chemical 5, Utility 3, Utility 7, Utility 8 | Chemical 1, Chemical 4, Chemical 6, Utility 2, Utility 4, Utility 5, Utility 6 | Utility 1, Steel 2 (pre-2019) | Chemical 3, Steel 1, Steel 2 (post-2019), Steel 3, Steel 4, Steel 5 |
| Nature of conflict | Decarbonization objectives | Science-based emission-reduction targets for own operations (Scope 1+2) and for supply chains/customers (Scope 3). | Emission reductions targets for own operations (Scope 1+2). | No carbon-emission–reduction targets. | Emission-reduction targets contingent on breakthrough technologies (Steel 1, Steel 4); emission-reduction targets for specific business units (Steel 2). |
| | Extent of goal congruence | High | Limited | Low | Low |
| | Institutional demands taken on board | Climate stewardship. Decarbonization pathway articulated (backed up by planned investments) to achieve significant emission reductions; provision of low-carbon products accounts for majority of business. | Profit and climate stewardship. Purpose of green (sustainable) solutions is articulated, but a significant proportion of product portfolio remains non-sustainable. The constraint on turning all products into "sustainable solutions" is customers' willingness to pay: where they are able to pay premiums and company has means of providing them, sustainable solutions are prioritized. | Profit. To deliver financial results to shareholders, not to "solve the climate problem."<br>Conflict between financial and decarbonization pressures. | Profit. To deliver financial results to shareholders, not to "solve the climate problem."<br>Conflict between financial and decarbonization pressures. |
| | Climate risk as opportunity or threat? | Climate risk is an opportunity to transform the business and win race to the future. | Climate risk has opportunities but also poses threats to parts of the business. | Climate change (risk) is seen as a conspiracy against business. | Climate risk is seen as an existential threat to the business. |
| Internal representation | Carbon price | On average, €28 per ton of carbon. Used in investments and scenario analysis, applied as penalty to business-unit P&Ls. | On average, €58 per ton of carbon. Used in screening products, investment appraisals, M&A targets' due diligence. | Not in use. | On average, €32 per ton of carbon. Used in investment processes and scenario analysis. |
| | Scenario analysis | Used to assess impacts of climate-related policy and market developments on business model and strategies. | Used to assess impacts of climate-related policy and market developments on business model and strategies. | Not in use. | Used to investigate worst-case scenarios (ramifications of inaction) and low-carbon technology pathways with various cost parameters (carbon prices, energy prices, etc.). |
| | Carbon footprints | Monitor carbon footprint of products across life cycle (from raw materials sourcing to disposal); calculate carbon savings enabled by products. | Calculate carbon footprint of specialized low-carbon products. | Not in use. | Generally not in use. |

## 4.7 Discussion: Climate Risk as Linguistic Cleansing

We observed that turning climate change into a management object required various acts of quantification and the construction of a new management category, *climate risk*. This construction went hand in hand with a performative act of *linguistic cleansing* (Barnhizer, 2013), a language control strategy deployed by adherents of the market logic, to respond to the challenge of the climate-stewardship logic by combining and reformatting the notions of “counting carbon” and “reducing emissions” to “managing climate risk”. At stake are the dominant modes of governance over the climate crisis: which staff functions will carry out the requisite calculations, and what roles should the state, corporations and the “markets” assume in decarbonization? This is why language cleansing, the construction of the notion of climate risk, involves – besides quantification – the shaping of the moral, management and ideological imperatives surrounding the climate change problem.

*Climate risk – moral imperatives*

Just a decade ago, there was widespread evidence that carbon-intensive companies defied environmental demands or complied with them only symbolically (Bowen, 2014; Hopwood, 2009; Oreskes & Conway, 2010). However, in light of the reformatting of an abstract climate emergency into an “existential climate risk", even the most technologically challenged organizations register the *moral imperative* to search for strategies to accommodate—or compromise with—decarbonization demands. The notion of climate risk also allows for hybridizing (Miller et al., 2008): modifying accounting practices to enable the envisionment and quantification of threats, costs and opportunities, and thereby the promotion of both the climate-stewardship and the market logic.

As shown in previous studies, accounting has a special role to play in mediating plural logics as moral imperatives. Ezzamel et al. (2012), for example, showed how three distinct institutional logics—a business logic, a governance logic, and a professional logic—

interacted with budgetary processes to produce variation in organizational practices in the UK educational system. Depending on political ideologies and the extent to which the new budgeting practices were advantageous or detrimental, organizational actors leveraged different institutional logics to contest, modify, and revise budgetary processes (Ezzamel et al., 2012). Similarly, Amans, Mazars-Chapelon, and Villesèque-Dubus (2015) showed that the use of budgets in two French theatre organizations was shaped by different institutional logics. Reflecting on the significance of budgetary processes as the implicit nexus of institutional logics and organizational activity, Kaufman and Covaleski (2019) observe:

> "Activity can only occur through financial support for staff and related expense, and a significant indicator of activity deemed legitimate is its priority for resource allocation. Viewed through this lens, the budget document emerges as a concrete representation of institutional logics in action." (Kaufman & Covaleski, 2019, p. 54)

In our study too, it was in the nexus of investment appraisal and resource allocation that climate-stewardship concerns found an inroad to modify existing calculative practices by charging a "carbon price" to operations and products – thereby not only quantifying, but also economizing (Kurunmäki et al., 2016) the otherwise intangible effects of climate change. Such an act of quantification and reformatting has a moral imperative: it redraws the line around permissible and acceptable activities by excluding certain (emissions-intensive) operations and products as too much risk. But such boundaries are malleable and negotiable: while Green Transition strategies explicitly demanded a wholesale business model overhaul, Green Segmentation allowed "business as usual" portfolio segments to co-exist with green ones. The notion of "green" was highly dependent on experts' choice of the level of carbon price – an ammunition as well as an enforcement tool – and the way they included or excluded other parts of the value chain (Scope 1-3 vs. Scope 1 and 2 only) in the calculations that punished carbon-intensive operations and product lines.

Thus accounting was mobilized to construct legitimate, company-appropriate goals and the means to achieve them, reflecting the multiple logics inherent in particular organizational perceptions and framings of climate risk. At the same time, calculative practices facilitated the construction of the notion of "climate risk". Again, by visualizing the downside of climate inaction (with the use of scenarios), the cost of climate action (with the combination of scenarios and emissions-adjusted investment appraisals) and, in some cases, the potential upside of climate action (scenarios to influence policy work), accounting both reflected and contributed to the variety of strategic responses, implying not only a moral, but managerial imperatives too.

*Climate risk – managerial imperatives*

As far as management imperatives are concerned, our study accords with previous work on dual logics that identifies two approaches to hybridization. *Structural segmentation* (Dunn & Jones, 2010; Greenwood et al., 2011; Pache & Santos, 2010, 2010) involves keeping competing or conflicting demands separate and assigning different operations and structural units to deal with them. *Blending* (Glynn & Lounsbury, 2005) involves adopting practices that "integrate" the competing logics, often leading to a "dilution" of one or the other.

Structural segmentation characterized firms in our sample that managed to construct and market profitable green solutions. They did this by creating niche strategies ("Green Segmentation"), having adopted calculative practices that were capable of demarcating profitable green products and customers. But structural segmentation was also apparent in the creation of a new staff function (dedicated to "sustainability") that engaged with powerful institutional referents in order to negotiate climate-appropriate goals and adjust the policy environment by, for example, securing subsidies for green technology development ("Engagement Strategies"). These engagements were facilitated by a pre-existing calculative infrastructure, new (sustainability) experts and practices that companies mobilized (or hired in) to explain to policymakers their requirements in order to be able to compromise (Oliver, 1991) and deliver on an acceptable decarbonization scenario. In 2019, at the beginning of our study, we found two cases illustrating defensiveness or, possibly, decoupling; both firms engaged in defensive responses, such as communication strategies to conceal their internal focus on maintaining their *status quo* business model ("Defensive Strategies"). Yet by mid-2021, both companies had switched to active Engagement.

The *blending* of logics was apparent in firms in our sample that managed to embrace decarbonization to the extent that it replaced the original business model ("Green Transition"). This was often the result of a wholesale divestment of carbon-intensive operations.

One occurrence of blending, taking place in the investment community—and thus outside our case-study firms—was the construction of the notion of "climate risk" by the TCFD. The notion of climate risk involves a powerful blending of the market and climate-stewardship logics. A new category of risk—climate risk—facilitates a discourse on (a) the financial effects of climate change on companies (market logic) and (b) their decarbonization goals (climate-stewardship logic). But categorizing climate risk as a species of business risk also suggests that it entails both threats and opportunities, implying in turn that climate-risk management may be a source of shareholder value (CDP, 2019b; TCFD, 2020). The adoption of the climate-risk language (along with its accompanying calculative apparatus of goal-setting, scenario analyses, and cost-benefit analyses) underlines the role of accounting, finance, and risk-management tools and processes in blending the dual logics of the market and climate stewardship. That is, by turning the notion of climate crisis into climate risk, corporations—following the lead of the investment community with its Task Force on Climate-Related Financial Disclosures—are turning the seemingly unmanageable, system-level problem of global warming into a managerial object that can be dealt with by corporate strategic responses. It is here that the ideological imperatives of the climate-risk discourse become clear.

*Climate risk - Ideological imperatives*

The TCFD and its advocates and followers display a steadfast belief in "market forces" and in the ability of investors and corporations to manage (and adapt) to climate change. This notion, echoing the market logic, stands in a stark ideological contrast to critical studies that suggest the issue of climate change is too big to be left to corporations (Gray, 1992, 2010; Wright & Nyberg, 2017) or, for that matter, to accountants alone (Gray, Walters, Bebbington, & Thompson, 1995; Spence, Chabrak, & Pucci, 2013). Corporations and accountants, the critics argue, merely adopt "an environmental flourish" to the commercial terms in which they view nature (Andrew & Cortese, 2013; Spence et al., 2013). Proponents of the alternative logic call for a pluralistic mode of governance that could facilitate true environmental (and climate) stewardship (McDonough & Braungart, 2002).

This is what makes companies' liaison with stakeholders "difficult political work". Nevertheless, we found a growing acknowledgment from our case companies that neither markets, nor corporations can do the required green transition alone. While corporations are willing to invest in the green transition, they are also expecting governments (and taxpayers) to subsidize their green investments and make that transition profitable for them. As far as the prevailing governance mechanism is concerned, we are seeing a renegotiation and reallocation of the roles – and power – of business *vis a vis* governments (as well as supranational actors), the outcome of which is still to be seen. In this contest, climate change has been reformatted as climate risk, predicated on the moral and ideological right of business to earn profits – and to only undertake business if it is profitable. But the notion of profit is being challenged by hybrid definitions that attempt at taking into account the climate-related costs imposed on society by corporations. At stake is not only the allocation of the costs and rewards of decarbonization, but also the extent to which societies are willing to allow the reach of markets to coordinate climate action, as opposed to defining it as a collective performance.

## 4.8 Conclusion and directions for future research

While the institutional complexity of the dual logics of climate stewardship and the market is the background of our study, our key insight is that firms reconcile the dual logics of climate stewardship and the market by the "managerialization" of the climate crisis: the transformation of the seemingly intractable system-level problem of climate change into an issue manageable by corporations.

Empirically, in our case studies we observed the rise of four specific corporate response strategies in different assemblages of technologies – both calculative and production technologies – and policy environments. We argued that the responses emerged and co-evolved with these assemblages (of experts, calculative practices, technologies, and policies) that they were necessarily part of. Specifically, the acquiescent response strategy (Oliver, 1991) that we call *Green Transition* has co-evolved with (1) a so called climate-saving – low-carbon -footprint – asset and technology base (Colgan et al., 2021; Paterson, 2021) that may be available for certain sectors, but not for others, (2) a new "sustainability-accounting" technology capable of costing carbon internally (effectively penalizing carbon-intensive products and technologies), as well as (3) the acceptance of the notion of climate risk as an opportunity, allowing incumbents to embrace more ambitious, "science-based" decarbonization targets. Firms may also avoid (Oliver, 1991) the tension between climate stewardship and the market logic by partially decarbonizing their business; creating what we call *Green Segmentation* strategies. These have co-evolved with certain green technologies and a pricing infrastructure that together created and visualized low-carbon market segments.

Managers look for and construct these segments only when they believe that such opportunities exist. The role of calculative technologies here was to bring that belief about by visualizing, quantifying and economizing those opportunities. These calculations also demarcated the boundary between the green business segments that were deemed as profitable, and the rest of the business portfolio, shielding the latter from further decarbonization demands.

In 2019, at the beginning of our study, we found two cases illustrating defensiveness or, possibly, decoupling; both firms engaged in defensive responses, such as communication strategies to conceal their internal focus on maintaining their *status quo* business model (*Defensive Strategies*). This response co-evolved with a predominantly "climate-forcing" asset portfolio (Colgan et al., 2021; Paterson, 2021), in companies that regarded commercially viable green technologies as little more than a fantasy. Yet by mid-2021, both companies had switched to active *Engagement Strategies*. Under pressure from policy makers for decarbonization, they now experienced an existential threat on maintaining the status quo. Climate change as an abstract threat became a tangible "climate risk", visualized by various policy scenarios, produced by new staff functions specializing in "sustainability". Some of the scenarios envisioned the destruction of carbon intensive firms via policy making (e.g. by the loss of licence to operate) or financials (e.g. by rising carbon taxes). Hence defensive corporate responses switched to a search for compromise (Oliver, 1991), via Engagement with policy-makers, regulators and investors to create incentives and technological enablers, and to harness subsidies provided by governments for innovation that these firms had yet to deliver if they were to travel a credible path towards decarbonization.

Our findings make two contributions. First, we extend work on responses to institutional complexity—that is, how organizations reconcile pluralistic institutional demands or logics (e.g., Oliver, 1991, Greenwood et al., 2011; Pache & Santos, 2010, 2013; Smets & Jarzabkowski, 2013; Smets, Morris, & Greenwood, 2012)—by focusing on the role of calculative practices in creating goal congruence. The organizational literatures on institutional complexity and accounting suggest that we may anticipate the rise of hybrid organizational structures and hybrid management and accounting practices (Miller et al., 2008; Pache & Santos, 2010). Yet managerial research on institutional complexity (i.e., how organizations reconcile pluralistic organizational demands) focuses on the leadership practices that create goal congruence through, for example, leadership and the development of a common organizational identity (Battilana & Dorado, 2010; Besharov, 2014). We examine *goal congruence as a dynamic alignment* of institutional demands and a corporation's contextual and idiosyncratic predisposition, mediated by calculative practices. In particular, we shed light on the technological dimension as an important antecedent of the apparent diversity of strategic responses to climate change. That is, some of the "climate-forcing" assets/technologies—those unaligned with decarbonization goals—can be complemented or substituted by "climate-saving" assets/technologies (Colgan et al., 2021; Paterson, 2021), subject to the rationales created by accounting calculations targeting the investment and policy context.

Second, we contribute to work on the "quantifying, economising and marketising" of public and organizational life (Kurunmäki et al., 2016; Miller & Power, 2013) by examining the ways in which a new risk-management concept—climate risk—is being mobilized by economic actors in order to reconcile the tensions between the market and the climate-stewardship logics. We proposed the notion of *linguistic cleansing* as an important capability of risk management: by blending the market (opportunity) logic with the social imperative logic of the day (in our case, decarbonization), organizational risk management reformats a system-level problem (climate change) into a managerial—and seemingly manageable—object (climate risk). At the same time, risk management shifts the underlying logic of appropriate governance from a predominantly state-driven response to climate change (i.e. climate stewardship by regulating corporate actors) to a primarily market-driven response enacted by corporate actors with various degrees of dependence on governmental support (i.e. market logic enacted by largely self-regulating corporate actors). However, we warn about the limitations of efforts to managerialize the climate crisis and underline that this is ultimately a political project—as one of our interviewees put it, "*This is difficult political work*"—by which corporations fight to retain power and autonomy as they search for "solutions" and negotiate the extent of "necessary" policy interventions with state actors.

The emerging forms of governance over the climate crisis needs further exploration. Climate risk, with its emerging host of calculative tools (ranging from adjusted profit figures to extensive scenarios) may entrench existing ways of doing or, on the contrary, may promote new forms of collectivity, by challenging long-held relationships between activities and notions of performance, between assets and value. The emerging forms of governance over climate will vary considerably between policy, geographical and ideological environments. Our study accords with accounting research contending that the world is made up of assemblages, of many heterogeneous aspirations, alliances and artefacts (Kurunmäki et al., 2016; Miller & Power, 2013). As climate risk has emerged as one of these new artefacts, we need to further explore the aspirations and alliances – expert groups, regulators and advocates – that shape its conditions of possibility.

## 4.9 Appendix Chapter 4

**Table 4.4: Overview of Cases**

| Case | Business activities | Carbon cost intensity* | Interview partners (function) | Data (27 interviews, archival data) |
|---|---|---|---|---|
| Chemical 1 | Speciality chemicals, commodity chemicals | 15% | IP1 (finance), IP2 (strategy) | 2 interviews (initial), corporate reports, CDP data |
| Chemical 2 | Speciality chemicals | 3% | IP3 (risk) | 1 interview, corporate reports, CDP data |
| Chemical 3 | Commodity chemicals, speciality chemicals | 8% | IP4 (finance), IP29 (finance) | 2 interviews (initial & follow-up), corporate reports, CDP data |
| Chemical 4 | Speciality chemicals, commodity chemicals | 13% | IP5 (sustainability) | 1 interview, corporate reports, CDP data |
| Chemical 5 | Speciality chemicals | 1% | IP6 (sustainability) | 1 interview, corporate reports, CDP data |
| Chemical 6 | Speciality chemicals, commodity chemicals | 12% | IP7 (sustainability) | 1 interview, corporate reports, CDP data |
| Steel 1 | Commodity steel | 80% | IP8 (sustainability), IP9 (technology) | 1 interview, corporate reports |
| Steel 2 | Commodity steel | 119% | IP10 (sustainability) | 2 interviews (initial & follow-up), corporate reports, CDP data |
| Steel 3 | Speciality metals | 10% | IP11, IP12, IP30 (all sustainability); IP13 (risk) | 2 interviews (initial & follow-up), corporate reports, CDP data |
| Steel 4 | Commodity steel | 22% | IP14 (sustainability) | 1 interview, corporate reports, CDP data |
| Steel 5 | Specialty steel & metals | 37% | IP15 (sustainability) | 2 interviews (initial & follow-up), corporate reports, CDP data |
| Utility 1 | Energy generation (fossil fuels) & trading | 65% | IP16 (sustainability); IP17 (sustainability) | 2 interviews (initial & follow-up), corporate reports, CDP data |
| Utility 2 | Energy generation (fossil fuels, renewables) & trading | 158% | IP18 (sustainability) | 2 interviews (initial & follow-up), corporate reports, CDP data |
| Utility 3 | Energy transmission & distribution; customer services | 6% | IP19 (sustainability); IP20 (sustainability) | 1 interview, corporate reports, CDP data |

| | | | | |
|---|---|---|---|---|
| Utility 4 | Energy infrastructure (gas) | 2% | IP21 (sustainability) | 1 interview, corporate reports, CDP data |
| Utility 5 | Energy generation (fossil fuels, renewables); trading, transmission & distribution | 21% | IP22 (finance), IP23 (sustainability) | 1 interview, corporate reports, CDP data |
| Utility 6 | Energy generation (fossil fuels, renewables); transmission & distribution; water services | 27% | IP24 (sustainability) | 1 interview, corporate reports, CDP data |
| Utility 7 | Energy generation (fossil fuels, renewables); transmission & distribution; customer services | 15% | IP25 (strategy), IP26 (strategy), IP27 (strategy) | 1 interview, corporate reports, CDP data |
| Utility 8 | Energy generation (fossil fuels, renewables); transmission & distribution | 24% | IP28 (finance) | 1 interview, corporate reports, CDP data |

*Own calculations. Carbon cost as percentage of EBITDA. Carbon cost is calculated as total carbon emissions (Scope 1+2) of companies at a carbon price of €25 (average price of EU ETS emission allowance in 2019). This figure does not represent the actual financial costs incurred by companies, but it indicates the vulnerability of business models to carbon prices.

# 5 TCFD Climate Risk Disclosures: Early Evidence on the "Gold Standard"

## 5.1 Introduction

*"Climate risk is investment risk."* – Larry Fink, CEO of Blackrock, 2020 Letter to CEOs

Climate change is arguably the greatest existential threat to humanity (Attenborough, 2020; Oreskes & Conway, 2013).[31] Capital markets participants, standard setting bodies, and securities regulators have finally begun to acknowledge the extreme importance of climate change, and they're doing so with an increasing sense of urgency. Considering this widespread awakening, which has been several years in the making, it is surprising to hear allegations of continuing grossly unmet investor demand for corporate disclosures related to the business risks and opportunities that climate change poses to companies' prospects. Investors have been resoundingly and persistently complaining that they lack consistent, reliable firm-specific climate related data to help inform their investment decisions, a complaint that was recently echoed by U.S. Securities and Exchange Commissioner, Allison Herren Lee. Lee has stated that, despite much voluntary disclosure in the sustainability space, investors are still not getting the material climate-risk-related financial information that they need (Herren Lee, 2020). The mandating of climate risk disclosures has therefore been placed at the top of the SEC's agenda, following similar moves by other major regulatory and standard setting bodies around the world (CFTC, 2020; Herren Lee, 2021).

[31] See also the IPCC Sixth Assessment Report (Masson-Delmotte et al., 2021), the declaration of the UN Secretary-General António Guterres on May 15th, 2018 (United Nations, 2018), and the call for action by the Nobel Prize Summit in April 2021 (Nobel Prize Summit Steering Committee, 2021).

This alleged dearth of climate risk data is an oft-repeated but somewhat surprising claim given that the Task Force on Climate-Related Financial Disclosures (TCFD) has been established by the Financial Stability Board (FSB) since 2015 with a mandate to fill this gap.[32] The TCFD, a private-sector-led taskforce, published its recommendations on climate-risk-related financial disclosures in 2017, and a growing number of companies have been voluntarily reporting under its guidelines since 2018. Globally recognized as the “gold standard” for climate-related disclosures (Mooney & Nauman, 2020), the TCFD recommendations were born out of a market need for enhanced company-provided information when it became clear that markets were not adequately pricing in climate-related risks (CFTC, 2020). The distinguishing feature of the TCFD’s climate-related financial disclosure recommendations is that they are designed to elicit *company-provided* information about the risks and opportunities that the firm faces as a result of climate change - i.e., disclosures related to *the impact of climate change on the firm,* rather than information about *the firm’s impact on the environment* such as the greenhouse gas emissions that have been the topic of considerable prior capital markets research (e.g., Matsumura et al., 2014, Jung et al., 2018, Aswani, Raghunandan, & Rajgopal, 2021, amongst many others). Thus, although other stakeholders may also find the information to be of interest, the TCFD’s specific mandate is to help to improve the quality and consistency of corporate disclosures related to climate information targeted at the firm’s *financial stakeholders*, including lenders, shareholders, and insurers. Since its inception, the Michael Bloomberg-chaired TCFD has received an extremely high level of support. As of March 2021, the TCFD reports having more than 2,000 supporters from 78 countries, with a market capitalization of over $19.8 trillion, including 859 financial institutions responsible for

[32] According to their website, the FSB, “through its members, seeks to strengthen financial systems and increase the stability of the international financial markets… The FSB promotes international financial stability; it does so by coordinating national financial authorities and international standard-setting bodies as they work toward developing strong regulatory, supervisory and other financial sector policies…” (Financial Stability Board, 2021).

assets of $175 trillion (TCFD, 2021b). Support for the TCFD continues to grow rapidly, with the framework having recently received strong endorsements from numerous influential players, including: Blackrock CEO, Larry Fink; U.S. Treasury Secretary, Janet Yellen; Mark Carney, the UN Special Envoy on Climate Action and Finance (and former Governor of the Bank of Canada and Bank of England); the UK's Financial Conduct Authority; the Sustainable Finance Action Council just established by the Government of Canada; as well as the IFRS Foundation in the context of its proposed establishment of a new set of global sustainability standards, amongst many others.[33]

To the best of our knowledge, ours is the first study to present large sample evidence related to voluntary disclosures made to the CDP in accordance with the TCFD reporting framework.[34] We focus on a sample of firms from advanced economies plus South Africa. The number of companies from around the world who are responding to the CDP's annual questionnaire has grown from 300 in 2004 to over 9600 in 2020, while those responding to the TCFD-related questions exhibit similarly increasing year-over-year trends (e.g., from over 1,538 in 2018, the first TCFD reporting year, to 1,937 in 2020).[35] Nevertheless, while new companies are joining each year, in contrast to the usual assumption that corporate voluntary disclosure practices are highly "sticky" and principally expanding over

[33] In his 2020 and 2021 letters to CEOs, Blackrock's Larry Fink asked all companies to report in alignment with the recommendations of the TCFD (Fink, 2020, 2021). In a statement to the Institute of International Finance on April 22nd, 2021, Janet Yellen endorsed the TCFD climate reporting framework (Yellen, 2021). In February 2020, Mark Carney declared that "Every major systemic bank, the world's largest insurers, its biggest pension funds and top asset managers are calling for the disclosure of climate-related financial risk through their support of the TCFD." Following its pledge to cut emissions by 40%-45% by 2030 and its commitment to net zero by 2050, on May 13th, 2021, the Government of Canada established the Sustainable Finance Action Council, indicating that the Council's "early emphasis will be on enhancing climate-related disclosures in Canada's private and public sector, in alignment with the TCFD recommendations" (Segal, 2021). In December 2020, the UK's Financial Conduct Authority issued a policy statement requiring companies with a UK premium listing to include a statement in their annual financial report whether their disclosures are consistent with TCFD recommendations (FCA, 2020). This is part of a broader roadmap to make TCFD-aligned disclosures mandatory in the UK by 2025 (HM Treasury, 2020).

[34] As we explain in Section 2, the CDP (formerly known as the Carbon Disclosure Project) is an NGO that sends surveys to thousands of firms around the world every year, soliciting carbon emissions data and other firm-specific climate-related information.

[35] These figures are based upon the total responses to the questionnaire, not just those from the advanced economies that we focus on in our analyses.

time, we also observe a non-trivial amount of attrition. For example, more than 162 firms that provided responses to TCFD-related climate risk questions in 2019 did not volunteer information related to climate risks in the 2020 survey. This large sample finding from the CDP database echoes anecdotal accounts documented elsewhere (e.g., Mikes & Metzner, 2021) that companies are disinclined to continue their participation in the surveys because the costs to complete them outweigh the benefits that they are expected to yield.

Prior to examining the determinants and market valuation implications of the TCFD disclosures, we begin with an examination of the raw data purchased from the CDP. This leads to some surprising revelations. Focusing our manual review on the disclosure of financial impacts of climate risk, a critical information item solicited by the TCFD framework, we observe that the CDP database is riddled with errors and irregularities. We note that there is no requirement that the data provided to the CDP be audited, although a high proportion of firms report receiving some level of assurance on their disclosures. Because there is no alternative authoritative source against which to validate the CDP data, our review is only able to definitively detect the most egregious of errors (i.e., those that are internally inconsistent), and to flag those that appear to be suspect (i.e., those that are likely to be erroneous, but for which the correctness cannot be fully confirmed or refuted), and therefore the documented cases of concern represent a lower bound on the potential irregularities in this database.[36] Notwithstanding the constrained nature of our review, we nevertheless estimate that at least 7% of financial impact disclosures are problematic and not suitable for use, and a further 9% are potentially suspect.[37] Although the number of

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[36] In response to private correspondence regarding the irregularities that we uncovered, as well as in their product offering descriptions, the CDP reports that they do some reasonableness checks on company responses, but that they do not certify the data's correctness.

[37] By way of example, the CDP requests that companies disclose the financial impacts of climate risks in plain numbers (e.g., 10,000,000), but some companies erroneously report their financial impacts as percentages. Similarly, the CDP allows firms to report in their home currency, however the system through which the questionnaire was administered in 2018 did not allow entry of numbers with more than 12

definitively problematic cases that we identify is declining over time (e.g., from 366 in 2018 to 220 in 2020), and the most egregious shortcomings of the questionnaire seem to have been remedied, the error rate is arguably still quite unacceptably high. Importantly, the CDP is the only authoritative body directly gathering company-provided climate information on a widescale basis, data that it solicits in a standardized format that should lend itself to regularity and tabulation, and as such it is currently the only prospect for the provision of global, consistent data, reported in accordance with a common framework. Yet despite the fact that companies responding to the TCFD-related questions are those that are likely to be amongst the most committed to identifying, monitoring, managing, and reporting climate-related risks, the CDP database containing this company-furnished data is not reliable without significant user intervention to attempt to purge the dataset of erroneous cases.[38] We conclude from this review that, while the TCFD reporting *framework* may well have considerable merit, the data that it generates via the single global repository for this company-provided data (i.e., the CDP) is certainly not of "gold standard" quality.

Our first set of investigations examine the determinants of the firms' respective decisions to: i) respond to the CDP questionnaire; ii) identify physical and/or transition risks in accordance with the TCFD framework; and iii) provide TCFD-solicited estimates of the financial impact of the identified climate risks. Consistent with the results from prior (typically single-country) studies of firms' other environmental disclosure decisions (e.g., GHG emissions), we find that firm size, capital expenditure intensity, and institutional ownership are each positively associated with the CDP response and TCFD disclosure decisions. Indicators of the firm's overall commitment to sustainability, such as having a

digits. This was particularly problematic for large South Korean companies reporting in Won (i.e., their figures inevitably exceeded the allowable digits).

[38] Because companies may not be publicly disclosing this information elsewhere, or they may be disclosing it only in part, in a non-standardized format, and/or in their home country language, it is not reasonably possible to correct the errors with a view to rendering all of the responses useful.

sustainability sub-committee of the board of directors, the establishment of an environmental management system, the production of a sustainability report, and overall environmental performance are each also incrementally significant determinants of firms' disclosure propensities, and the firm's industry and the location of its headquarters are also important. The percentage of independent directors on the board increases the propensity for disclosure in the absence of controls for the firm's commitment to sustainability, but board independence reduces forthcomingness once commitment to sustainability has been controlled for.

We next investigate whether the act of disclosure has signalling value, and separately whether the number of climate risks, or the estimated financial impacts of climate risks, are reflected in market prices. Firms that respond to the CDP survey, and especially those that provide the additional TCFD-compliant information, are evidently measuring and tracking this important data for internal decision-making purposes. As such, the mere act of disclosing these climate risks may provide a signal to the capital markets that disclosing firms are more focused on, and/or adept at, *managing* these risks. Our empirical tests indicate that, while the firm's decision to respond to the CDP questionnaire is positively associated with firm value, indicators capturing the decisions to furnish the more investor-specific TCFD disclosures are not. Overall, we conclude that the evidence does not strongly support the hypothesis that the provision of climate risk information is a credible signal of the firm's advanced level of measuring and managing climate risks, or at least that it is not a signal to which the market is attentive, on average across reporting firms.

We further examine whether the number of physical risks and transition risks disclosed by the firm in compliance with the TCFD framework are associated with firm value. Considering that managers primarily have incentives to talk up their firm's share price, the negative connotations implied by specific identification of material physical and transition risks should make these risk disclosures inherently credible (i.e., at least as a lower bound on the firm's risk exposures). Thus, *a priori,* the test of value relevance for these risk disclosures could be a "straw man," with the refutation of the risk counts' value relevance being highly improbable, particularly in light of the extremely high level of support for TCFD-compliant disclosures, in combination with the alleged investor demand for climate risk information. On the other hand, leading regulators, practitioners, and academics claim that climate risks are not being fully priced (Arnold, 2020; CFTC, 2020; International Monetary Fund, 2020a; Schnabel, 2020), and specifically that there is a lack of awareness of, or appreciation for, the TCFD framework (Hook & Vincent, 2021; OMB Research, 2021).

Our results lend support to each of these perspectives. First, we show that the number of transition risks disclosed by the firm are negatively associated with firm value, consistent with these risks being viewed by investors as credible threats to the firm's business model as the world transitions to a low-carbon economy (i.e., as unrecorded liabilities or impaired assets). By contrast, physical risks are not significant in valuation regressions, nor are the allegedly coveted firm-provided estimates of the financial impacts of climate change. Our findings imply that investors don't understand the TCFD disclosures that firms are voluntarily furnishing to the CDP, that they are inattentive to this information, and/or that they simply do not view the risks and estimates provided in the disclosures as credible, probable, proximate in time, and/or material to firm value.

Our analyses are important because the demand for sustainable investments has been exploding in recent years, with global sustainable investment estimated to be $35.3 trillion at the start of 2020, accounting for up to 35.9% of total assets under management (Global Sustainable Investment Alliance, 2021). Institutional investors are correspondingly clamoring for relevant, reliable, and consistently measured climate-related information, and regulators are stepping up practices to assist in the elicitation of what the providers of capital need. Notably, several countries have already begun to specifically mandate TCFD-compliant disclosures (e.g., the UK, New Zealand, Switzerland, and Canada under certain circumstances), while the U.S. SEC has confirmed that it plans to issue new climate-related disclosure rules before the end of the year, and pundits expect that these new rules may be largely based upon the TCFD framework (Johnson & Schroeder, 2021). Our findings from a large global sample suggest that, when voluntarily-provided, TCFD-compliant information is largely not being reflected in share prices, even when companies report that their climate risk disclosures have been assured. The potential net benefits from mandating TCFD disclosures, which will impose significant costs on reporting entities, are thus far from obvious.

The rest of this paper is organized as follows. Section 5.2 provides institutional background related to the CDP and the TCFD framework, while Section 5.3 reviews the literature and develops hypotheses. Section 5.4 describes our sample and data, Section 5.5 investigates the determinants of firms' climate risk disclosure decisions, and Section 5.6 examines the capital market implications of the disclosures. Section 5.7 concludes.

## 5.2 Institutional Background and Overview of CDP Data

### 5.2.1 Corporate Climate Risk Reporting

Similar to the rest of the ESG reporting landscape of which it is a part, corporate climate related reporting is the subject of numerous alternative frameworks and reporting standards.[39] To address perceived weaknesses associated with existing all-purpose

[39] The Global Reporting Initiative (GRI), the Sustainability Accounting Standards Board (SASB), the International Integrated Reporting Council (IIRC), the Climate Disclosure Standards Board (CDSB), as well as the UN Global Compact through its Principles for Responsible Investing initiative, all speak to climate risk disclosure issues in one way or another. The EU's Non-Financial Reporting Directive (NRFD), which is subject to a proposed replacement by an EU Corporate Sustainability Reporting Directive (CSRD), is also important to this landscape, as is the Partnership for Carbon Accounting Financials for financial

sustainability disclosure frameworks, a number of standard-setting organizations were established to focus on the most "pressing" element of the ESG agenda; namely, climate change (Barker & Eccles, 2020).

Founded in 2000, the Carbon Disclosure Project (later simply "CDP") was an early attempt to promote and gather corporate disclosures on climate-related issues. The CDP encourages companies to voluntarily disclose their impact on climate change, particularly by measuring, reporting, and setting reduction targets for their greenhouse gas (GHG) emissions. Focused on the company's *impact on the environment*, CDP disclosures are of interest to a wide variety of stakeholders, including shareholders.[40] Indeed, there is a significant body of academic research documenting the price-relevance of emissions disclosures for both equity (e.g., Clarkson, Fang, Li, & Richardson, 2013, Matsumura et al., 2014, Bolton & Kacperczyk, 2021, amongst many others) and debt markets (e.g., Herbohn, Gao, & Clarkson, 2019), although Aswani et al. (2021) question the validity of the inferences drawn from some of these studies.

From the perspective of analyzing the financial risks and opportunities that climate issues pose for a firm, however, such carbon emissions disclosures are necessary but not sufficient. A critical missing element from ESG-related corporate disclosure frameworks that focus on *the firm's impact on the environment* and/or society is the disclosure of information related to the *impact of climate change on the firm.* Consider that there are a multitude of climate-related issues over which the firm has no control or significant influence (e.g., global warming), which may nevertheless have material consequences for the

institutions. Barker and Eccles (2018) provide a more extensive review and discussion of the various ESG-related standard-setting agencies, although the landscape has evolved considerably since that time.

[40] Shareholders may be interested in the firm's $CO_2e$ emissions because of the increase in carbon emissions tax and allowance schemes that may affect the firm's cost structure and viability, because of changing consumer preferences for more environmentally friendly products (affecting each producer in the supply chain), because of changing financial capital providers' tastes favoring more sustainable companies, or due to any number other similar reasons that result in the firm's own $CO_2e$ emissions potentially influencing the firm's financial prospects.

company. For example, the $CO_2e$ emissions of a real estate holding company with significant waterside assets in Miami may be miniscule (and in a state that is less likely than most to impose carbon taxes that would significantly impact profitability), however a 2-degree rise in global temperatures could render the firm's assets worthless. In such cases, the firm's own $CO_2e$ emissions disclosures do not nearly adequately capture the existential threat that climate change poses to the entity. Absent additional information, corporate climate-related risks (and opportunities) are therefore unlikely to be properly incorporated into corporate decision-making, or properly priced by the market.

As explained by Mark Carney, the UN Special Envoy on Climate Action and Finance, former Governor of the Bank of Canada and of the Bank of England, and former Chairman of the Financial Stability Board, any failure to incorporate climate risk into investment decisions is not only jeopardizing to business models, but also puts the entire financial system at risk (Carney, 2015). Recognizing the systemic risks associated with climate change, in 2015 the Financial Stability Board established the Taskforce on Climate-related Financial Disclosures (TCFD) "to develop recommendations for more effective climate-related disclosures that could promote more informed investment, credit, and insurance underwriting decisions" (TCFD, 2021a). The TCFD's reporting framework, which requests that firms *report on the impact of climate change on their business* (i.e., rather than their business' impact on the environment), is radically different from previous sustainability reporting models. Chaired by Michael Bloomberg, the TCFD is supported by more than 2,000 entities from around the world with a combined market capitalization of over $19.8 trillion, including financial institutions responsible for assets of $175 trillion (TCFD, 2021b, p. 32).

The TCFD's reporting guidelines divide risks into two major categories: i) risks related to the *transition* to a lower-carbon economy; and ii) risks related to the *physical* impacts of climate change (TCFD, 2017b, p. 5). *Transition* risks include policy and legal risks, such as the financial impact of carbon taxes or climate-related litigation (e.g., PG&E's triggering of California wildfires that resulted, in part, from a prolonged drought). Also included in this category are market risks (e.g., related to the supply and demand for commodities); technology risks, such as the development of renewable energy, battery storage, and energy efficiency; as well as reputational risks related to consumer and societal preferences (or even tolerances) changing during the low-carbon transition. *Physical risks* may be event driven (acute) or due to longer-term shifts (chronic) in climate patterns. An example of the latter is provided by the Miami real estate firm mentioned above, whereby an increase in global temperatures over time will result in a sea level rise that could eventually lead to asset submersion. Examples of acute risks include the increasing frequency and intensity of hurricanes affecting the Southeastern U.S., flooding in Bangladesh, Germany, China, and elsewhere, or wildfires engulfing Australia and California. The TCFD also recognizes that there are climate-related *opportunities* related to resource efficiency, alternative energy sources, new low-emission products and services, new markets, and in developing resilience, and the framework explicitly attempts to elicit company-provided insights into these climate-related upsides as well.

It is expected that a firm's identification and description of the material physical and transition risks that it faces, as well as their estimates of the financial impacts of climate risk, if credibly conveyed, would be informative to a fundamental analyst of the firm. In addition to signalling the firm's active monitoring and management of these risks, which is of no trivial importance, the details provided by firm insiders should meaningfully inform analysts' own subjective evaluations of the climate-related risks and opportunities being faced by the firm, and particularly their expected financial impacts. When added to the emissions data that was previously being solicited by the CDP, it is easy to see why the TCFD became known as the "gold standard" of corporate climate-related reporting, as well as why it has the backing of the most influential players in global capital markets, including the IFRS Foundation that is expected to subsume it, as well as SEC Commissioners and other important members of IOSCO. However, under the heretofore voluntary disclosure regime of the TCFD in which the information furnished is not required to be audited, is apparently not meaningfully reviewed by the CDP for accuracy and comprehension, and that is therefore strewn with errors, we discuss in the next section why there is little shine and potentially not much utility associated with some aspects of these disclosures.

### 5.2.2 CDP Questionnaire and Data

The CDP surveys companies that are publicly traded, amongst the largest firms in their country of headquarters, have high GHG emissions, or if they have previously responded to the CDP survey.[41,42] Beginning in 2018, the CDP survey was expanded to include questions designed to elicit the information proposed by the TCFD framework. Survey participation is entirely voluntary, it is not directly tied to any country-specific legislation, and companies report that the survey is extremely time- and resource-intensive to complete. By way of example, the .pdf version of the full 2019 climate change questionnaire is 185 pages long. Corporate respondents complete the CDP survey via an online form that includes closed- and open-ended questions, and they can elect whether to make their responses available to the public. The closing deadlines for responding to the survey have varied over the years, but generally fall between June and August. The CDP consolidates responses by late fall, and it makes this data available (for companies that have elected to have it shared publicly) on its website. While an individual company's responses can be

[41] The CDP's investor request process for the most recent survey period of 2021 is available here: https://6fefcbb86e61af1b2fc4-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/comfy/cms/files/files/000/004/393/original/CDP_Climate_Change_Sample_Investor_Request_2021.pdf

[42] Further details related to the TCFD's survey procedures and our approach to replicating their sampling procedure are provided in Appendix A.

freely accessed on the CDP's website, the full dataset of consolidated responses is available only to CDP signatories for a small fee, and to other members of the public (e.g., academics) for a more substantial price. The data obtained from companies who elect not to have their responses made public is available to institutional level subscribers to the CDP, a relationship level that only seems to be available to institutional investors (CDP, 2021). The CDP claims to do some light review of the data, but none of the submitted data are required to be audited, nor are they apparently subject to serious scrutiny before being consolidated by the CDP and sold on to the public.

In the CDP questionnaire section related to information sought under the TCFD framework, companies are requested to provide financial impact estimates of climate risks. Our initial inspection of the financial impacts data for each of the three years for which it is available revealed some concerns, which led us to undertake a review of 100% of the 11,443 climate risk financial impact disclosure observations available for publicly-listed firms from advanced economies and South Africa.[43] Since the survey responses are the only available "source data", our review consisted of checks for internal consistency between the quantitative financial impact figures and the textual explanations contained in each company's responses. Based upon this reconciliation, 825 financial impact observations (7% of total) were deemed to be problematic due to the various issues summarized in Figure 5.1,[44] a further 1,047 (9%) could not be verified either because no textual explanations were provided and/or because the text was in Japanese. The remaining 84% of observations did not exhibit obvious data integrity concerns, although we would

[43] The set of observations reviewed is consistent with those included in our sampling frame, as explained in Section 5.4 and Appendix A (i.e., companies from advanced economies plus South Africa), except for the following differences: First, the final sample used in our regression analyses excludes companies from the financial sector and companies with any missing data. Second, the unit of observation for the data verification is the climate risk financial impact disclosure, of which there may be several per firm per year (i.e., on average, companies disclosing financial impact estimates provided information related to 4.22 climate risks per year), whereas the unit of observation for our regression analyses is the firm-year.
[44] See Appendix C at the end of Chapter 5.

emphasize that our 7% error rate is almost certainly a lower bound on the extent of potentially problematic cases.

As shown in Figure 5.1, the most common errors were that the respondent replied at the wrong level of aggregation (e.g., they reported on a particular process or activity rather than at the aggregate company level), that the response was in the wrong units (e.g., financial impacts are disclosed as percentages instead of plain numbers in a specified currency), or that the same aggregated financial impact figure was provided for different individual climate risks (e.g., the same financial impact of weather-related events is supplied for both acute and chronic physical climate risks). While some of these errors could potentially be corrected with some painstaking effort, most of them cannot be adjusted with the information made available. Overall, considering that the TCFD-compliant information being gathered by the CDP is known as the "gold standard" of company-provided climate risk information, we were very surprised and disappointed by both the rate, and the nature, of the errors that we observed. Furthermore, we consider the confirmed and suspected errors to be a lower bound on the data concerns that are likely to be embedded in the CDP database. Accordingly, we include only a limited set of analyses using the detailed financial impact data, and we would recommend that other potential users of this aspect of the CDP database proceed with extreme caution.

## 5.3 Related Literature, Theory, and Hypothesis Development

A large body of extant research examines the determinants of firms' voluntary sustainability reporting decisions, as well as the implications of sustainability disclosures for the firm's cost of capital and/or firm value (Christensen et al., 2021).[45] Corporate social responsibility (CSR) reporting differs from traditional financial reporting in a number of

[45] We use the terms "sustainability" and "CSR" interchangeably in the discussions that follow.

important ways, including: i) the potential audience for CSR reporting is broader; ii) CSR is not sharply defined, it encompasses a broad range of topics; iii) CSR reporting has many objectives and responds to the preferences of numerous stakeholders beyond investors; iv) CSR activities are not necessarily measured in monetary terms, nor otherwise on a consistent basis across activities (or, in the current absence of agreed upon frameworks, across firms or even by the same firm across time); v) CSR disclosure has historically been largely voluntary, although this is changing rapidly in many jurisdictions; vi) CSR activities are often embedded in the firm's strategy, and are expected to yield benefits over longer-term horizons, which makes them difficult to measure and report upon over shorter intervals; and vii) externalities play a central role in CSR activities and reporting.[46]

A considerable amount of the extant research related to voluntary CSR reporting focuses on climate-related disclosures, much of which specifically investigates carbon emissions. We discuss the literature related to the determinants of voluntary disclosures and the information content of the disclosures, respectively, in the following two sections.

### 5.3.1 Determinants of Voluntary Climate-Related Disclosures

Hahn et al. (2015) identify two complementary theoretical perspectives that explain disclosure decisions: sociopolitical theories of disclosure, and economic theories of (voluntary) disclosure. Sociopolitical theories (e.g., Gray, Kouhy, & Lavers, 1995) view disclosure as firms' response to social, political and stakeholder pressure, a perspective that suggests that climate-risk disclosure can be explained as a response to stakeholder demand for information about how climate change will be (is) impacting businesses. Previous studies that explain *climate-related disclosure* in these terms include Liesen, Hoepner, Patten, and Figge (2015) in a European setting, and Reid and Toffel (2009) in the U.S. context. Also consistent with the sociopolitical perspective, countries with higher

[46] This list is derived from Christensen, Hail, and Leuz (2021).

corporate-governance and disclosure norms have been shown to exert higher pressure for carbon disclosure (Choi & Luo, 2021).

Economics-based theories of disclosure, while acknowledging the forces of institutional pressure, also argue that companies will undertake a cost-benefit analysis before opting for voluntary reporting (e.g., Verrecchia, 1983). This perspective recognizes that demand for discretionary disclosure of corporate information arises from the inevitable information asymmetry that exists between corporate insiders and the firm's other stakeholders, and suggests that firms will optimize their disclosure policy in a manner that maximizes firm *value* (Core, 2001).[47] This more narrow perspective fails to consider agents' broader mandate of maximizing shareholder *welfare*, which is not necessarily the same thing (Christensen et al., 2021; Hart & Zingales, 2017), and the differences are likely to be considerably more important in the context of sustainability-related disclosure decisions. Nevertheless, while it is still reasonable to assume that corporate environmental disclosure decisions will involve a rational cost-benefit analysis, the decisions about whether to disclose climate risk information are complicated by a lack of consensus (and knowledge) about how to measure these risks, and whether they are likely to be credible and material to decision makers, given that climate change predictions are generally uncertain and involve very long time horizons (Christophers, 2019).

In the context of financial capital markets, the benefits from disclosure are expected to include a reduction in the information asymmetry component of the cost of capital. Signalling theory (e.g. Milgrom, 1981; Connelly, Certo, Ireland, & Reutzel, 2010) suggests further benefits in that financial markets, regulators, employees, customers, and/or other stakeholders may reward firm transparency in the form of reputational enhancements.

[47] Healy and Palepu (2001) and Beyer, Cohen, and Lys (2010) provide comprehensive and insightful summaries of the disclosure-related literature.

With respect to environmental disclosures, in particular, reputational benefits may accrue in the form of cash flow gains from increased or premium-priced sales, from having access to more motivated and/or more talented employees, from being able to negotiate more favorable terms with suppliers, and/or from greater access to cheaper financial capital in markets that put a premium on sustainable investment opportunities. We hasten to emphasize that the potential signalling value of environmental risk disclosures to the providers of financial capital is not only expected to be driven by stakeholders' "green preferences." Rather, to the extent that stakeholders recognize that climate risk is a real threat to a company's prospects, the firm's disclosure acts as a signal of potential real risk reduction (or optimal risk management) at the firm level, as disclosing firms may be assumed to better monitor, measure, and manage these risks.

The costs of disclosure in general include the potential release of proprietary information, the establishment of a measurement, tracking, and reporting system, and perhaps the additional need to have the disclosures assured by an independent third party to render them more credible. In the environmental realm, foreseeable costs also include the potential negative reputational costs if the firm is not perceived to be performing in line with stakeholder expectations. The latter may lead to adverse consequences that are opposite to the previously listed benefits (e.g., loss of access to/retention of talented employees, loss of sales or higher costs to maintain the same level of sales, higher costs of financial capital, etc.), in addition to the possible costs that could arise from the firm being targeted by activist campaigns (shareholders, customers, or the general public).

In the following sections we discuss the specific firm characteristics that the prior literature has investigated, and summarize the extant results concerning the determinants of environmental disclosures.

*Size, Financial Performance, and Asset-Liability Structures*

Larger firms face heightened political pressure to disclose their emissions, they are better equipped to bear the costs associated with a carbon emissions tracking system, and they may be better positioned to bear any proprietary costs that may ensue if the firm disappoints some of its constituents with its climate-related performance (Liesen et al., 2015). Consistent with this, numerous studies have documented that firm size is positively associated with the likelihood of carbon emissions disclosure (Clarkson, Li, Richardson, & Vasvari, 2008; Liesen et al., 2015; Matsumura et al., 2014).

Similarly, more profitable firms are expected to have the resources and managerial attention required to implement the management information systems to track environmental performance metrics. Consistent with this, the prior literature documents that profitability is positively related to the voluntary disclosure of carbon emissions (Choi & Luo, 2021; Liesen et al., 2015; Ott, Schiemann, & Günther, 2017).

Other firm financial characteristics that have been shown to be related to firms' environmental disclosures include their growth prospects (Matsumura et al., 2014), leverage (Matsumura et al., 2014), and capital intensity (Clarkson et al., 2008). Our analyses also consider the role of firms' investments in internally-generated intangible assets (e.g., Demers, Hendrikse, Joos, & Lev, 2021) as some pundits consider these to be intimately related (albeit in unspecified ways) to the firm's sustainability activities and/or performance.

*Ownership and Governance Characteristics*

Institutional investors have a higher demand for climate-related information and may even require this information as a condition for investment, resulting in documented higher levels of disclosure by firms with greater institutional ownership (Ilhan, Krueger, Sautner, & Starks, 2020; Krueger et al., 2020). On the other hand, Matsumura et al. (2014)

assert that firms *seeking* a greater institutional shareholder base are those most likely to disclose, suggesting perhaps the opposite relation between disclosure and institutional ownership.

Blockholders have been found to have a disclosure-decreasing influence as firms with closely-held ownership are unlikely to be responsive to public investors' demands for information given that controlling shareholders already have access to the relevant data (Cormier & Magnan, 1999).

A greater presence of independent directors and the existence of a sustainability committee at the board level have each been found to result in a higher likelihood of disclosure (Jaggi, Allini, Macchioni, & Zagaria, 2018). Intuitively, the firm's establishment of an environmental management system that enables them to track, measure, and manage climate-related information has also been shown to be a determinant of environmental disclosures (Ott et al., 2017).

*Environmental Performance and Attestation*

Theory suggests that firms that are superior in terms of their environmental performance are more likely to disclose such performance metrics in order to reveal their type (Milgrom, 1981; Spence, 1973). Consistent with this, Clarkson et al. (2008) and Matsumara et al. (2014) provide empirical evidence using U.S. samples that firms with better environmental performance are more likely to provide voluntary environmental disclosures.

### 5.3.2 The Relevance of Climate-Related Disclosures to Financial Markets

*Signalling and Information Asymmetry Reduction Through the Act of Disclosure*

Disclosure of private information reduces information asymmetry between firm insiders and the providers of capital (Healy & Palepu, 2001). Whether it is good or bad news that is being released, the provision of information reduces uncertainty and is expected to lead to a lower cost of capital, ceteris paribus. Consistent with this, using a sample of U.S. firms, Dhaliwal, Li, Tsang, and Yang (2011) find that the initiation of CSR reporting results in a lower cost of capital.

With respect to carbon and climate risk disclosures, signalling theory would suggest that a firm that discloses its carbon emissions and/or climate risks is signalling not only its ability to measure these emissions and risk exposures, a prerequisite for managing them (Matsumura et al., 2014), but also its superior performance (Clarkson et al., 2008). Moreover, climate-related disclosures provide investors with information about potential future costs that firms may incur due to changes in regulations, consumer preferences, or market dynamics triggered by societal efforts to mitigate climate change. Being able to readily access this information, investors do not need to undertake costly information searches such as purchasing estimates of firms' carbon emissions from third party providers. In line with these arguments, prior research finds that firms disclosing their carbon emissions enjoy higher firm valuations and lower cost of capital relative to non-disclosing firms. Employing propensity score matching and doubly robust regressions, Matsumura et al. (2014) document that median firm value is $2.3 billion higher for S&P 500 firms with disclosed carbon emissions compared to firms without emissions disclosures. This is consistent with Bolton and Kacperczyk's (2020) finding that the voluntary disclosure of Scope 1 GHG emissions is associated with lower stock returns.

Recent studies have extended the scope of this research from considering the capital market implications of emissions disclosures to examining the consequences of providing information about climate risk exposure more broadly. Studying a sample of 717 European companies, Schiemann and Sakhel (2019) document that the voluntary disclosure of firms' exposure to physical climate risks is associated with lower information asymmetry. Flammer et al. (2021) conduct an event study of U.S. S&P 500 companies disclosing climate risks through the CDP questionnaire after being targeted by environmental shareholder activism. Assessing the stock market response around the day on which the climate risk disclosure is released to the public, the study finds that companies disclosing climate risks achieve higher stock market valuations post-disclosure.

Following from both information asymmetry and signalling theories, as well as the prior empirical environmental disclosure literature, we similarly expect that in the context of our international sample of firms and their decisions related to CDP questionnaire response, as well as the disclosure of TCFD-solicited climate risk information, that voluntary disclosure will lead to a higher market value, ceteris paribus. Specifically, we hypothesize the following with respect to each of the disclosure decisions that we investigate:

*H1A: Respondents to the CDP questionnaire have a higher firm value, ceteris paribus.*

*H1B: Firms disclosing physical and/or transition risks (collectively, climate risks) in accordance with the TCFD framework have a higher value, ceteris paribus.*

*H1C: Firms providing estimates of the financial impacts of climate risks in accordance with the TCFD framework have a higher value, ceteris paribus.*

Notwithstanding the theoretical plausibility of such predictions, we note that these hypotheses are not without tension. Numerous reports suggest that TCFD disclosures have not meaningfully captured the attention of practitioners. For example, an HSBC survey of 2,000 investors found that just 10 per cent of respondents viewed TCFD disclosures as a relevant source of information, claiming, "[d]espite all the talk about TCFD, at the moment we don't see it being used in discussions with credit rating agencies, in discussion with mainstream investors — it is still a very niche agenda item" (Hook & Vincent, 2021). In the U.K., where legislation is now in place to *mandate* TCFD-compliant corporate climate risk disclosures by 2025, a recent survey of defined benefit (DB) pension plan managers prepared for The Pensions Regulator found that less than 50% of all DB schemes allocated time and resources to assessing any financial risks and opportunities associated with climate change (although the proportion was 70% for large schemes), and that fully 71% of respondents (including 59% of large DB scheme respondents) were not even aware of the TCFD (OMB Research, 2021).

*Information Content of Climate Risk Disclosures*

A considerable body of prior research has investigated the association between firm value and the levels, or amounts, of environmental issues disclosed in corporate communications. Beginning with Barth and McNichols (1994), the early literature examined the capital market implications of corporate environmental issues through the lens of unbooked liabilities, that is, firms' exposure to potential future costs arising from environmental regulations. This strand of literature has found that the exposures to such environmental liabilities are associated with lower firm value (Barth & McNichols, 1994; Cormier & Magnan, 1997; Hughes, 2000). Much of the subsequent literature examining the value-relevance of carbon emissions as a proxy for environmental obligations has adopted a similar framework, hypothesizing and finding that carbon emissions are negatively associated with firm value (Chapple, Clarkson, & Gold, 2013; Choi & Luo, 2021; Clarkson, Li, Pinnuck, & Richardson, 2015; Griffin, Lont, & Sun, 2017; Matsumura et al., 2014). Although the basic finding of a negative relation between emissions and firm value is consistent across most studies, the economic significance of this relation differs between geographies and time periods, and results are sensitive to how emissions are measured (Aswani et al., 2021). For example, Matsumura et al. (2014) use an unscaled measure of total Scope 1 and Scope 2 GHG emissions for a sample of U.S. firms and find that every additional ton of emitted carbon is associated with a $212 reduction in firm value for S&P 500 companies. Studying the same empirical setting, but scaling carbon emissions by shares, Griffin et al. (2017) report a market-implied equity discount of $78.8 per ton of carbon emissions for the median S&P 500 company in their sample. Using a sample of 58 Australian firms, Chapple et al. (2013) document a 6.57% valuation penalty for firms with high relative to low carbon intensity, defined as GHG emissions scaled by sales revenue.

All these findings of a negative association between emissions and firm value are consistent with the notion that carbon emissions disclosures capture imposing threats of regulation and/or other expected real costs as the economy transitions to a lower carbon reality. However, the heterogenous firm value discounts documented in prior studies indicate that the value relevance of carbon emissions is likely to differ across institutional and geographical contexts. Consistent with this, Clarkson et al. (2015) find that for firms that are subject to the European Emission Trading Scheme, only those carbon emissions that are not covered by free emission allowances are associated with a valuation penalty, which they estimate to be €75 per ton of emissions. Similarly, using a global sample of 1,748 firm-year observations from 28 countries, Choi and Luo (2021) find that the negative association between carbon emissions and firm value is stronger in the presence of a national emissions trading scheme. Bolton and Kacperczyk (2021) also document some cross-country differences in the pricing of firms' carbon emissions, but overall they find a consistent, positive association between carbon emissions and stock returns for firms in all sectors across three continents (Asia, Europe, North America).

Notably, all the preceding studies examine the association of firm performance, returns, and/or value with a measure of *the firm's impact on the environment* (i.e., emissions), which is at best an indirect and incomplete measure of the potential cost to shareholder value associated with the environmental issues that firms face. Considering the body of evidence supporting the value relevance of such a weak proxy for the total climate risks being faced by the firm, it seems reasonable to expect that the “gold standard” TCFD disclosures that we examine, which are designed to measure the more shareholder relevant *impacts of climate risk on the firm*, would quite obviously be associated with firm value.

For several reasons, however, there is more tension related to this hypothesis than it might appear at first blush. First, Aswani et al. (2021) revisit the issue as to whether $CO_2$e emissions are associated with firm performance, and their results call into question the conclusions of earlier studies. These authors find that emissions levels are only associated with stock returns when the emissions are measured in metric tons of $CO_2$e, but not when they are measured in terms of carbon intensity (i.e., $CO_2$e emissions scaled by sales), which is the measure most used by practitioners. Furthermore, and of direct relevance to the TCFD-compliant disclosures that we investigate, Aswani et al. (2021) find that emissions are only associated with returns when emissions data are estimated by data purveyors, *not when the disclosures emanate from the firm*, and further that emissions are not associated with performance when the analyses incorporate industry effects.

Secondly, anecdotal accounts stemming from representatives of leading organizations around the world similarly suggest that climate risk more broadly (i.e., beyond $CO_2$e emissions) is not being adequately priced by the capital markets. For example, BNY Mellon (2019) reports that 93% of survey participants "regard climate change as an investment ‘risk’ that has yet to be priced in by all the key financial markets globally.” The IMF similarly reports that climate change physical risk does not appear to be reflected in global equity valuations, leading the organization to call for global mandatory disclosures on material climate change risk (International Monetary Fund, 2020a). The U.S. Commodity Futures Trading Commission (CFTC) has arrived at similar conclusions, claiming that, “in the case of climate risk, neither the expected impacts – nor the potential for extremely bad outcomes – is being priced appropriately" (CFTC, 2020, xx). Christine Lagard, President of the European Central Bank, has expressed a similar opinion in the international arena (Arnold, 2020). Consistent with these mostly anecdotal perspectives, a recent survey of academics, professionals, and public sector regulators and policy economists reports that, "[b]y an overwhelming margin, respondents believe that asset prices underestimate climate risks" (Stroebel & Wurgler, 2021, p. 1). With respect to TCFD disclosures in particular, a GSIA (2019, p. 5) investor poll reports that "87% said they do not believe that markets are consistently and correctly pricing climate risks into company and sector valuations."

Despite this skepticism, a recent study by Koelbel, Leippold, Rillaerts, and Wang (2020) uses a textual analysis of U.S. firms' 10-K reports to investigate whether the corporate climate risks disclosed in these filings are priced by the credit default swap (CDS) market. Differentiating between physical and transition risks, as suggested by the TCFD framework, Koelbel et al. (2020) find that transition risks increase CDS spreads, especially after the Paris Climate Agreement of 2015, but they do not find any such significant effect for physical risks.

In summary, there is now even conflicting evidence related to the value-relevance of the more pervasive and generally well-understood corporate carbon emissions disclosures. Combined with the many anecdotes and survey evidence suggesting that TCFD disclosures are either not well understood or not being attended to by investors, and notwithstanding the unanimously strong support for the TCFD framework on the part of many regulatory bodies and other important players in the global capital markets, the extent to which this alleged "gold standard" of climate risk reporting will be reflected in market prices is far from obvious.

## 5.4 Data, Sample, and Descriptive Statistics[48]

### 5.4.1 Sample

Data related to corporate voluntary reporting of climate related risks was purchased from the CDP for their reporting years 2018 through 2020.[49] Our analyses focus on companies headquartered in advanced economies plus South Africa, excluding financial firms.[50] Panel A of Table 5.3 reports the total number of publicly-traded CDP respondents by country for each of the three CDP reporting years for which we have data. On a country basis, the greatest number of respondents are from the U.S., followed by Japan, the U.K., and France. However, if considered as a bloc, the EU would rank first in terms of the absolute number of CDP survey responders. Together, companies from the EU, U.S., Canada, and Japan account for more than 80% of the total firm-year responses to the surveys for the years shown. Panel B provides the distribution of respondents by industry sector for each year, with the data indicating that firms in the industrial, consumer discretionary, and materials sectors together account for nearly 50% of firm-year responses.

In order to model firms' decisions about whether to disclose, we require a sample of firms that are expected to have been *invited* to respond to the CDP survey, not just those who

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[48] All tables referenced throughout this chapter are included in Appendix C at the end of Chapter 5.

[49] The CDP labels their data based on the year in which the company *reports* the climate related information. The deadline by which companies are required to respond to the survey has varied from July 31st to August 26th, and thus for most companies a "2018" CDP reporting year corresponds to the company's 2017 fiscal year. To align CDP data with financial data, we assume that companies with fiscal year end months of January through June that are reporting to the CDP in 2018, e.g., are reporting for their fiscal year 2018, while companies with year ends from July through December that are reporting in 2018 are reporting for their fiscal year ending in 2017. For the latter group (i.e., the majority of companies in the sample), we merge the 2018 CDP data to their 2017 financial data and refer to this as a "2018" observation because this is the year of the climate risk disclosure decision. Our results are not sensitive to alternatively assuming that only companies with year ends from January to March file CDP reports in the year that corresponds with their fiscal year end (which is not surprising given that relatively few firms in the sample have year ends from April through June, and also given that many of the explanatory variables are "sticky" from year to year).

[50] We identify advanced economies based upon the definition provided by the International Monetary Fund (International Monetary Fund, 2020b, p. 109). We include South Africa because integrated reporting has been mandatory for firms listed on the Johannesburg Stock Exchange for more than 10 years, which has led to an unusually high rate of climate risk disclosure for companies headquartered in South Africa. Our results are not sensitive to dropping the South African observations.

have actually replied. As discussed in Section 5.2, although the CDP's corporate invitation list is not consistently disclosed, their survey methodology is sufficiently transparent as to permit its approximate replication. Appendix A describes in detail our approach to replicating the CDP's selection of surveyed firms. We use Refinitiv's EIKON database to implement the stated selection criteria. This process yields the samples summarized in Panels C and D on a country-by-country and sector-by-sector basis, respectively, for each year included in the sample.

Panels E and F of Table 5.3 show the rates of response to the CDP questionnaire by country and by sector for each year. As expected, many European countries exhibit relatively high response rates. This is far from homogeneous, however, as evidenced by the spread between, e.g., Cyprus, Iceland, and others at the lower end, and Norway and Finland at the higher end of the range. Within the Asia-Pacific region, Japan has the highest rate of response, whereas Hong Kong and Australia are relative laggards. Surprisingly, the U.S. has a higher response rate than most EU countries, whereas the UK and Canada fall around the middle of the pack. In terms of industry response rates, the highest by far is utilities, traditionally a sector about which GHG emissions concerns abound, followed by consumer staples.

Panels G and H show the country and industry response rates to TCFD-aligned climate-related questions. Since these are a subset of the CDP responses, the response rates are systematically lower, but they otherwise exhibit similar tendencies in terms of countries' and industries' propensities to respond.

### 5.4.2 Data Sources

Data related to climate risk disclosures was purchased from the CDP. Blockholder share ownership data is derived from S&P's Capital IQ, and all other corporate financial, ownership, share price, CDS spread, and ESG data are provided by the Refinitiv EIKON database.

### 5.4.3 Descriptive Statistics

Panel A of Table 5.4 provides descriptive information related to the firms in our sample, and for the sub-samples of responding/non-responding firms for each of: i) the CDP survey; ii) climate risk questions; and iii) the financial impact of climate risk questions. As shown, respondents to each type of information request are significantly larger in terms of sales, total assets, market capitalization, and analyst following relative to non-respondents. Respondents to each of the three sets of questions also tend to be more profitable, as evidenced by their higher ROA. Respondents spend less on each of R&D and SGA as a percentage of sales, and slightly more on CapEx as a percentage of total assets, and they are also more leveraged. For the subset of firms for which $CO_2$e emissions data are available, we find that firms with higher emissions are more likely to respond to each of the three dimensions of the survey.

Panel B of Table 5.4 provides descriptive statistics for our regression variables. *CDP*, a firm-year indicator set to one if the company responds to the CDP questionnaire, indicates a pooled average response rate of 36%. *CR* and *FI*, indicators set to one if companies respond to the TCFD-aligned climate risk and financial impact of climate risk questions, respectively, indicate pooled response rates of 31% and 24%, on average, for each of these aspects of the questionnaire. Although firms responding to the CDP questionnaire are likely to be those that are most attuned to, and forthcoming about, climate-related disclosures, only 67% of CDP-responding firms provide the sought after financial impact information solicited under the TCFD framework. In untabulated analyses we also find that nearly (more than) 90% of firms providing climate risk (financial impact) information had previously responded to the CDP questionnaire, suggesting that it is very rare for firms to go from non-participation in the CDP survey to provided the more involved TCFD-compliant disclosures. Still, of those firms that had previously responded to the CDP questionnaire, approximately 12% and 29% don't provide climate and financial impact information, respectively, in the subsequent period. In other words, previously responding to the CDP questionnaire does not automatically lead to subsequent provision of the more complete and informative disclosures solicited by the TCFD, particularly with respect to the financial impact information that is potentially useful to investors. Firms that respond to the climate risk questions (i.e., those with *CR*=1), disclose, on average, 2.5 transition, 1.5 physical, and thus 4.0 climate risks in total.[51]

Over 59% of firms in our sample provide a sustainability report (*SustReport*), 49% have a formal sustainability committee (*SustCommittee*), 40% report having an environmental risk management system (*EMS*), and less than 17% of firms are signatories to the United Nations Global Compact (*UNsign*). For firms for which $CO_2e$ data is available, we observe that there is immense variation in $CO_2e$ emissions intensity across firms, and the ratio of $CO_2e$ to revenues is extremely right-skewed. Accordingly, in value- and risk-relevance regressions that incorporate emissions, we use the natural log of (1+ $CO_2e$/Sales) as the explanatory variable.[52]

Table 5.5 presents the correlation matrix for the variables used in our regressions. Not surprisingly, size is correlated with the existence of a sustainability committee, the production of a sustainability report, and the establishment of an environmental management system, albeit to a less significant degree than might have been expected. Each of these three indicators of heightened attentiveness to, and management of, sustainability-related

[51] For the sample as a whole, averaging across all firms including those that don't disclose any climate risk information, this implies the provision of .79 transition risks (*TransRisk*), .47 physical risks (*PhysRisk*), and thus a total 1.26 climate risks (*ClimateRisk*) as reflected in the averages shown in the table.
[52] We note that $CO_2e$ intensity is a scaled variable (i.e., it is $CO_2e$ emissions in tonnes scaled by revenues), so the variation and right-skewness in this raw ratio is not a simple manifestation of firm size.

issues is also predictably highly correlated with the others. As previously established in sample comparisons, the pairwise correlations confirm that the decisions to respond to each of the three elements of the survey are correlated with various measures of size, performance, asset tangibility, and financial structure.

## 5.5 Disclosure Decisions

In this section, we empirically investigate the determinants of three corporate disclosure decisions, including whether to respond to the CDP questionnaire, whether to disclose physical and transition risks in accordance with the TCFD framework, and whether to provide estimates of the TCFD-solicited financial impacts of climate risks, respectively.

### 5.5.1 Expected Determinants of Disclosure

Following from the prior literature, we expect that firm size, asset mix, and financial structure will impact the disclosure decisions, as will ownership and governance characteristics, the firm's industry and region of headquarters, as well as other indicators of the firm's commitment to sustainability and environmental performance. We discuss our empirical proxies for these variables each in turn.

*Size, Financial Performance, and Asset-Liability Structures*

Consistent with prior literature, we capture firm size using the natural log of sales (*logSales*), and we expect that it will be positively associated with the likelihood of disclosure (Clarkson et al., 2008; Liesen et al., 2015; Matsumura et al., 2014). Similarly, we expect that more profitable firms will have the requisite resources to respond to the CDP survey and to furnish the additional TCFD-related information, and we use net income scaled by total assets (*ROA*) as our proxy for profitability.[53]

[53] In untabulated analyses, we use earnings before interest scaled by total assets and operating earnings scaled by total assets as alternative measures of profitability, and all of our key inferences remain unchanged.

We also consider that the firm's growth prospects (Matsumura et al., 2014), leverage (Matsumura et al., 2014), capital intensity (Clarkson et al., 2008), and its level of investment in internally created intangible assets (Demers et al., 2021) may influence their propensity to disclose climate risk information. Our proxies for each of these respective constructs are the book-to-market ratio (*BTM*), long-term debt scaled by total assets (*LEV*), capital expenditures scaled by total assets (*CapEx*), and the stock of unamortized investments in internally developed intangible assets (*IntangStock*).[54]

*Ownership and Governance Characteristics*

Following the prior literature (Ilhan et al., 2020; Matsumura et al., 2014), we capture institutional ownership using the percentage of common equity held by institutions (*InstOwn*), and we expect this to positively influence firms' propensities to disclose climate-related information.

We construct an indicator variable that is set to one if the firm has a shareholder owning 5% or more of the common stock, and zero otherwise (*Block)*, and we expect that blockholders will have the opposite effect on disclosure (Cormier & Magnan, 1999).

We include the percentage of independent directors (*IndepDir*), an indicator set to one if the firm has a sustainability committee (*SustCommittee*), and an indicator set to one if the firm has an environmental management system in place (*EMS*), and we expect that each of these governance variables will be positively associated with the likelihood of disclosure.

*Commitment to Sustainability*

We include two additional variables that are designed to capture the firm's commitment to sustainability. *UNsign* is an indicator set to one if the firm is a signatory to the UN

[54] The calculation of *IntangStock*, as well as all other variables, are described in greater detail in Appendix B.

Global Compact, and is expected to be positively associated with the propensity for disclosure (Liesen et al., 2015). Firms that produce either a dedicated sustainability report, or that provide a section on sustainability in their annual reports, may be similarly signalling a higher commitment to environmental friendliness, and are therefore expected to be more likely to disclose. Given the propensity for greenwashing, however, it is possible that this variable will not be associated with the firm's decisions to disclose the detailed climate-related information requested by the CDP and the TCFD disclosure framework. We control for this using an indicator variable, *SustReport*.

*Industry and Country*

In addition to all of the preceding firm-specific attributes, we also expect that the sector in which the firm operates and the country or economic region in which it is headquartered will influence the firm's willingness to disclose climate-related information. We therefore include indicators for each of the 10 GICS sector classifications excluding the financial sector that was dropped from our sample (*industry*), as well as indicators capturing the firm's headquarters by country and/or region (*region*) using the following eight classifications: Canada, US, UK, EU+4, Australia, Japan + South Korea, South Africa, and HK+Taiwan+Singapore+Macau.

*Additional Determinants*

The firm's environmental performance is also expected to be an important determinant of their willingness to disclose environmental information (Clarkson et al., 2008; Matsumura et al., 2014). Unfortunately, the candidate control variables for this construct are only available for a subset of our sample, and therefore we include a control for environmental performance only in supplementary regressions. Our first proxy for this is the firm's industry decile ranking on the basis of GHG emissions intensity (i.e., $CO_2$e scaled by revenues), which we label *CO2eRank*. Given that prior value-relevance results are sensitive to emissions measurement, we also consider two additional alternatives: $CO_2e$ scaled by revenues (i.e., emissions intensity without industry-adjustment, or $CO_2e$); and to address the skewness of emissions, $logC02e$. Finally, we alternatively use the firm's Refinitiv environmental pillar score to capture its environmental performance.

*Voluntary Disclosure Decision Model*

Following from the previous discussions, the regression model used to examine the determinants of firm's climate-related disclosure decisions is as follows:

$$\begin{aligned} Disclose_{it} = {} & \beta_0 + \beta_1 logSales_{it} + \beta_2 ROA_{it} + \beta_3 BTM_{it} + \beta_4 LEV_{it} + \\ & \beta_5 CapEx_{it} + \beta_6 IntangStock_{it} + \beta_7 InstOwn_{it} + \beta_8 Block_{it} + \\ & \beta_9 IndepDir_{it} + \beta_{10} SustCommittee_{it-1} + \beta_{11} EMS_{it} + \\ & \beta_{12} UNsign_{it} + \beta_{13} SustReport_{it} + \textstyle\sum_{j=1}^{9} \delta_j\, industry_j + \\ & \textstyle\sum_{k=1}^{7} \gamma_k region_k + \varepsilon_{it} \end{aligned} \tag{1}$$

where $Disclose_{it}$ is alternatively an indicator that is set to one if firm *i* in period *t* chooses to respond to the CDP questionnaire ($CDP_{it}$), to provide TCFD-compliant climate risk information ($CR_{it}$), or to provide the TCFD-solicited estimates of the financial impact of climate risks on the firm ($FI_{it}$), and zero otherwise, and all explanatory variables are as previously explained and as defined in greater detail in Appendix B. Standard errors are clustered by firm and year in all specifications.

### 5.5.2 CDP Questionnaire Response

The results from probit regressions of Equation (1) examining the determinants of firms' decisions to respond to the CDP questionnaire are reported in Table 5.6. In the first column, we report the results using only the financial, ownership, and independent director variables, in the second column we report the same regression with industry and region fixed effects, and in the third column we add variables capturing the firm's commitment to sustainability.

Consistent with findings in earlier U.S. and other single-country studies examining emissions disclosure decisions, firm size, institutional ownership, and profitability are significantly positively associated with the firm's decision to respond to the CDP survey. The firm's stock of internally developed intangible assets (*IntangStock*) is a positive determinant of disclosure, as are capital expenditures, but the latter is only significant when variables capturing the firm's commitment to sustainability are excluded from the regression. A higher proportion of independent directors also increases the firm's propensity to respond to the questionnaire, but only when variables capturing the firm's commitment to sustainability are excluded from the regression. When the latter variables are included, the role of independent directors is to decrease the firm's propensity to respond to the CDP survey.[55] As expected, the establishment of a sustainability committee of the board of directors, the production of a sustainability report, the existence of an environmental management system, and being a UN Global Compact signatory all significantly increase the likelihood of firms responding to the CDP survey.

### 5.5.3 TCFD-Compliant Climate Risk and Financial Impacts Disclosure Decisions

In Table 5.7 we present the results of Equation (1) using the firm's decision to disclose physical risks and transition risks in accordance with the TCFD framework (collectively, climate risks, or *CR*) as the dependent variable. We find that most of the determinants of the firm's decision to provide this additional TCFD-compliant information are similar to those associated with the CDP survey response documented above. Specifically, firm size, institutional ownership, tangible asset intensity (*CapEx*), and the indicators

[55] This sign flipping is clearly suggestive of a potential multicollinearity problem, and the relatively high degree of pairwise correlation between *Indep_Dir* and some of the variables capturing the firm's commitment to sustainability heighten these concerns. Given that VIFs are not well-defined in probit analyses, in order to investigate the potential for multicollinearity amongst the variables, we rerun Equation (1) as an OLS regression. The VIFs calculated from this OLS regression are all well below traditional thresholds of concern, with the highest valued VIF being less than 3, suggesting that multicollinearity is not likely to have an undue effect on the reported probit coefficients.

capturing the firm's commitment to sustainability are all reliably associated with a higher likelihood of disclosure, and when the commitment to sustainability is controlled for, the coefficient on independent directors flips from positive to negative. The firm's capital structure (*LEV*) is now weakly significant, whereas neither *ROA* nor *IntangStock* are significant in explaining the firm's decision to identify their material climate risks.

In Table 5.8 we present the results from the same regressions using the firm's decision to provide quantitative estimates related to the financial impact of climate change as the dependent variable. Although only 24% of firms provide these disclosures (versus 36% and 31% responding to the CDP questionnaire and providing climate risk disclosures, respectively), the signs and significance of the coefficients on the explanatory variables are largely identical to those reported in the previous analyses.

### 5.5.4 Specifications Controlling for Environmental Performance

In Table 5.9 we present each of the fully specified decision model regressions using observations for which $CO_2$e emissions and the firm's overall environmental performance score are each respectively available. We first measure $CO_2$e emissions using the firm's sector decile ranking of $CO_2$e scaled by revenues (*CO2eRank*). As shown in Panel A, this variable is weakly significant in explaining the firm's decision to disclose climate risks, but it is not significantly associated with a higher likelihood of responding to the CDP survey or providing financial impacts information.[56] Panel B of Table 5.9 presents the results using the natural log of $CO_2$e emissions (*logCO2e*) to control for emissions performance. As shown, *logCO2e* is a significant determinant of the firms' decisions to disclose climate risk and financial impacts information, but it is not associated with the propensity to respond to the CDP questionnaire. Our inferences related to the other decision

[56] For parsimony, we do not tabulate the similar results found for all three decisions using $CO_2$e scaled by sales (*$CO_2e$*).

determinants are largely unaffected by the inclusion/exclusion of the emissions control variables, except that profitability (*ROA*) is now significant across the board when emissions performance is controlled for, and director independence (*IndepDir*).[57] We conclude from these tests that the role of $CO_2$e emissions as a determinant of TCFD disclosures is ambiguous as their significance is sensitive to how these emissions are measured.[58]

Panel C of Table 5.9 presents the results from each of the fully specified decision models after including Refinitiv's environmental pillar score (*EnvScore*) as the proxy for the firm's environmental performance. As shown, and consistent with prior research in the context of emissions disclosures (e.g., Clarkson et al., 2008), the firms' decisions to respond to the CDP questionnaire, to disclose climate risks, and to disclose the financial implications of climate risks, are all positively associated with their overall environmental performance. We conclude that the firm's overall environmental performance is a significant determinant of their propensity to disclose climate risk information.

### 5.5.5 Summary

To the best of our knowledge, ours is the first study to provide large scale global evidence related to firms' decisions to provide TCFD-compliant climate risk disclosures. Our evidence suggests that, although the rate of furnishing this information is considerably lower than that of the standard CDP responses, the determinants of these climate risk disclosures are generally similar. Firm size, institutional ownership, and indicators of the firm's commitment to sustainability, as well as industry membership and geographical region, are consistently significant determinants, whereas the firm's tangible asset intensity (captured by *CapEx* and *IntangStock*) and profitability (*ROA*) are not universally important.

[57] In untabulated tests, we rerun the decision models including/excluding the various $CO_2$e emissions variables using the constant sample for which these variables are available, and our inferences on the other determinants are not meaningfully different under the two alternative specifications.
[58] An alternative interpretation of the insignificance of the emissions variables is that the firms' emissions *are* an important consideration in their disclosure decisions, on average, but that the firm-level emissions data provided by the Refinitiv database are not reliably measured, resulting in attenuated coefficients.

Director independence increases the likelihood of all three forms of disclosure in the absence of sustainability commitment variables and environmental performance variables, but its role changes when these variables are controlled for. Finally, for the subset of firms for which data is available, we confirm that overall environmental performance is important to all three climate risk disclosure decisions, whereas the role of $CO_2$e emissions varies depending upon how emissions are measured.

## 5.6 Capital Market Implications of Disclosure Decisions

We next consider whether the market assesses any relevance to corporate climate risk disclosures by examining whether any of the three decisions to disclose, the number of risk factors disclosed, or the estimated financial impact disclosures are associated with firm value.

### 5.6.1 Signalling Value of Disclosure Decisions

In order to assess the signalling value of the climate risk disclosure decisions, we run the following pooled regression using Tobin's Q, defined as the market value of common equity plus the book value of debt, all scaled by the book value total assets, as the dependent variable:

$$\begin{aligned} Q_{it} = {} & \theta_0 + \theta_1 logSales_{it} + \theta_2 ROA_{it} + \theta_3 LEV_{it} + \theta_4 IntangStock_{it} + \theta_5 CapEx_{it} + \\ & \theta_6 SalesGrowth_{it} + \theta_7 Cash/Assets_{it} + \theta_8 Disclosure_{it} + \\ & \textstyle\sum_{j=1}^{11} \delta_j \, industry_j + \sum_{k=1}^{7} \gamma_k region_k + \varepsilon_{it} \end{aligned} \tag{2}$$

where *Disclosure* is alternatively defined as *CDP*, *CR*, and *FI* (i.e., indicators set to one when each respective disclosure has been provided), and all other explanatory variables are as previously explained and defined in detail in Appendix B. Standard errors are clustered by firm and year in all pooled specifications.

The results from this regression using all available firms in our sample are reported in Table 5.10. As shown, only the *CDP* decision indicator is significant. The positive coefficient on *CDP* is consistent with the prediction that voluntary disclosure of climate risk information will lead to reduced information risk and serve as a credible signal of the firm's commitment to measuring and managing these risks, which in turn results in higher firm value. However, when the result for *CDP* is considered together with the insignificance of the climate risk and financial impact decision indicators, the combined findings suggest that there is little information content conveyed by the firms' decisions to provide detailed climate risk information. This finding may result from the market's assessment that the act of disclosure alone is not a sufficiently credible signal of the firm's commitment to, or success in, measuring and managing climate risks (i.e., a substantial number of disclosing firms may be greenwashing). Alternatively, the results are also consistent with market participants not responding to the information contained in the disclosure decisions either because investors are unable to process the information signal being conveyed, or because they are simply not attentive to the disclosures. The latter interpretation is supported by anecdotal accounts and practitioner survey reports, as previously discussed in Section 5.3.

### 5.6.2 Value-Relevance of Physical and Transition Risks

We next investigate whether the *number* of disclosed transition and physical risks, respectively, are reflected in the firm's market value using the following regression:

$$Q_{it} = \theta_0 + \theta_1 logSales_{it} + \theta_2 ROA_{it} + \theta_3 LEV_{it} + \theta_4 IntangStock_{it} + \theta_5 CapEx_{it} + \theta_6 SalesGrowth_{it} + \theta_7 Cash/Assets + \theta_8 PhysRisk_{it} + \theta_9 TransnRisk_{it} + \theta_{10} IMR\_CR_{it} + \sum_{j=1}^{11} \delta_j \, industry_j + \sum_{k=1}^{7} \gamma_k region_k + \varepsilon_{it} \qquad (3)$$

where *IMR_CR* is the inverse Mills ratio from the first stage (i.e., Equation (1)) regression capturing the firm's fitted propensity to disclose climate risks (i.e., either physical and/or transition risks or both), and *PhysRisk* and *TransnRisk* are the counts of the number of physical risks and transition risks disclosed by the firm, respectively. The use of counts of the number risks disclosed as a credible proxy for the extent of risk being faced by the firm is supported by prior studies in the IPO literature (e.g., Beatty & Welch, 1996), as well as studies examining the information content of firms' 10-K risk disclosures (e.g., Campbell, Chen, Dhaliwal, Lu, & Steele, 2014).

The results from these regressions are reported in Panel A of Table 5.11. In the first column, both the estimated likelihood that the firm will choose to disclose climate risk related information and the industry and region fixed effects are omitted. The second column incrementally includes the fixed effects, and the third column additionally includes the inverse Mills' ratio (IMR) from the first stage regression modeling the firms' decisions to disclose climate risks (*IMR_CR*).[59]

As shown, the number of transition risks (*TransnRisk*) disclosed by the firm is negatively associated with firm value, whereas neither the number of physical risks (*PhysRisk*) nor the propensity to disclose climate risks (*IMR_CR*) is significant in explaining *Q*. The significant negative coefficient on *TransnRisk* suggests that the number of disclosed transition risks is being priced by the equity markets as a form of unrecorded liability or unrecognized asset impairment. Alternatively stated, the transition risks identified by the firm credibly convey value-destroying threats to the firm's business model that investors assess as having a sufficiently high probability and proximity as to have a material effect on firm value. By contrast, the identified physical risks are apparently viewed by the

[59] Following Matsumura et al (2014), who in turn cite Lennox, Francis, and Wang (2012) concerning the importance of imposing ‘‘exclusion restrictions’’ when using the Heckman procedure, we also exclude some of the explanatory variables of the first-stage disclosure decision from the second stage valuation model in order to avoid a multicollinearity problem at the second stage that could potentially bias the valuation model coefficients. Specifically, we exclude institutional ownership, the percentage of independent directors, and the various indicators capturing the firm's commitment to sustainability. In untabulated regressions, we rerun various specifications that include subsets of these variables. None of the variables is individually significant, and all of our key results are unchanged when the other variables are included.

market as not credible, improbable, remote, or immaterial, on average, as they are not significantly associated with firm value.

We undertake a number of untabulated specification checks related to the results reported in Panel A of Table 5.11. First, we sum the number of transition risks and physical risks into a single variable capturing the total number of climate risks disclosed (*ClimateRisk*). The combined count variable is not significant, consistent with the market viewing the credibility and/or materiality of each type of risk differently (as was also suggested by the opposite-signed coefficients in the previous baseline regression), and with their aggregation therefore creating a noisy measure of the material climate risks being faced by the firm. Second, we create an indicator that is set to one for firms with higher than median institutional ownership (*HighInst*), and we rerun the Equation (3) regressions including an interaction of *HighInst* with each of the physical and transition risk count variables, respectively, as well as the *HighInst* main effect. Neither the main effect nor the interaction terms are significant, suggesting that the number of disclosed risks are not differentially valued by the market for firms with higher levels of more sophisticated shareholders.

In a final specification check, presented in Panel B of Table 5.11, we consider whether independent assurance enhances the information content of the disclosed risks. Prior studies have shown that the cost of capital reduction induced by CSR disclosures is increased when companies provide assurance on their CSR disclosures (e.g., Casey & Grenier, 2014; Dhaliwal et al., 2011), that high-quality assurance statements on sustainability reports significantly reduce bid-ask spreads (Fuhrmann, Ott, Looks, & Guenther, 2017), and that analysts perceive the credibility of assured CSR reports to be greater in certain contexts (Pflugrath, Roebuck, & Simnett, 2011). To investigate the role of assurance in our setting, we create an indicator that is set to one if the firm's response to the CDP questionnaire indicates that climate-related information other than carbon emissions has been verified by an independent third party (*Attest*, and we include each of the *Attest* main effect, as well as the interaction of *Attest* with *TransnRisk* and *PhysRisk*, respectively, in the valuation regression. As shown, none of the three *Attest* variables are significant, suggesting that third party certification does not enhance the information content of climate risk disclosures in our setting.

In Table 5.12, we present year-by-year results of the Equation (3) valuation regressions.[60] The 2018 CDP survey was the first to include requests that firms disclose information in accordance with the TCFD framework, and thus 2018 disclosing firms may be considered "disclosure leaders" in the sense that they are the first to be forthcoming with the requested risk information. The number of physical risks disclosed *(PhysRisk)* is positively and significantly associated with firm value for 2018, suggesting that the provision of this risk information reduces the financial capital providers' information risk about the firm's physical climate exposures and/or that the disclosures signal the firm's more active monitoring and management of these risks (i.e., either of which would manifest in the observed higher enterprise valuation). By contrast, the number of transition risks disclosed by the firm (*TransnRisk*) is negatively associated with value, suggesting that the reduced information risk stemming from the firm's forthcomingness about these threats is insufficient to overcome the implications of the extent of climate-related challenges to the firm's fundamental business model (i.e., real operating risks). In other words, the reduced information risk is more than offset by the negative valuation implications of real climate risks to which the firm is admitting vulnerability as the world transitions to a lower carbon economy.

[60] Because these annual regressions include only one observation per firm and are all from the same year, the standard errors are not clustered.

The results for each of 2019 and 2020 in the subsequent two columns are similar to those for 2018 except that the number of physical risks is no longer associated with firm value in either year. Thus, after the first year in which the number of physical risks disclosed under the TCFD framework was positively perceived by financial market participants, there appears to have been a change in sentiment regarding the valuation implications of these disclosures in subsequent years. The results suggest that the risk reduction premium enjoyed by firms offering voluntary physical risk disclosures is no longer greater than the market's perception of the real effects that these risks pose to firm value, such that the net effect on value is zero. Alternatively, the insignificant coefficient may result from the market's assessment, after a year of learning, that the physical risk disclosures are not reliable and/or that the likelihood of their occurrence is too small or too distant on the horizon, and/or that the expected impacts are, on average, otherwise immaterial.

Overall, our results suggest that transition risks disclosed under the TCFD reporting framework have been consistently negatively valued by the market since the inception of TCFD reporting to the CDP. By contrast, physical risk disclosures were taken as a positive signal by the market in the initial year of this new reporting regime, but the apparent significance of this information to market participants has dissipated over time.

### 5.6.3 Value-Relevance of the Estimated Financial Impacts of Climate Risks

We rerun the valuation regressions including the estimated financial impacts of climate risks (*FinImpact*), instead of the counts of the number of physical and transition risks identified by the firm, using all available firm-years for which the *FinImpact* disclosure was provided and was not deemed to be erroneous or suspect.[61] As in the previous analyses, we control for the firm's propensity to disclose using the IMR from a first-stage

[61] We rerun these regressions including cases that are suspect, but not definitively erroneous, and the results are unsurprisingly unchanged in that *FinImpact* remains insignificant.

probit model of the *FinImpact* disclosure decision (*IMR_FI*), and we cluster standard errors by firm and year.

The results, shown in Table 5.13, indicate that firm-provided estimates of the financial impacts of climate change are negatively, but not significantly, associated with firm value. These findings suggest that the equity markets deem these estimates to be broadly unreliable, on average, or alternatively that too many observations containing problematic estimates may remain in our sample (i.e., such that the noisy data causes the coefficients on *FinImpact* to attenuate to zero). Alternatively, market participants may view the firms' estimated financial impacts to be credible, but that the likelihood and/or timing of their occurrence is too remote to have a material effect on value, or perhaps that the equity market adopts a more complex assessment of the value-relevance of the disclosures than is implied by our model.[62] Finally, the results are also consistent with market participants simply not understanding or not being attentive to these TCFD-compliant disclosures.

We run several untabulated specification checks related to these results. First, we enter the financial impacts of transition and physical risks separately, and we find that neither variable is significant. Second, we investigate the impact of attestation on the value relevance of financial impact estimates by including the interaction of *Attest* and *FinImpact*, together with the *Attest* main effect, and we find that attestation does not render the estimated financial impacts value-relevant at standard levels of significance. Finally, we run annual regressions and find that *FinImpact* is insignificant in each of the three years for which this TCFD-solicited information has been voluntarily reported, suggesting that the

[62] Recall that our *FinImpact* measure is a simple linear aggregation of all the financial impacts disclosed by the firm in a given year. It is conceivable, however, that fundamental analysts assess some of the firm's disclosed impacts to be sufficiently credible, material, probable and not too remote in time to be relevant for firm value, while they discount or dismiss entirely other disclosed financial impacts. If so, then the equal weighting scheme implied by our mechanical *FinImpact* summation may lead to a noisy proxy for the financial impacts that market participants consider to actually be relevant for firm value, attenuating the coefficients on our *FinImpact* measure towards zero.

insignificance of the cross-temporally pooled results are not being driven by learning in later periods.

In summary, even after removing observations containing erroneous or suspect financial impact data, considering the influence of attestation, allowing financial and physical financial impacts to be valued separately, and considering each reporting year separately, TCFD-compliant corporate disclosures of the potential financial impacts of climate risk as provided to the CDP exhibit no significant association with firm values. Considering the extent of support for the TCFD reporting framework amongst regulators and other important players in the global capital markets, as well as the associated increasing propensity to mandate these disclosures in numerous jurisdictions around the world, it's somewhat surprising to find that, when voluntarily provided, TCFD-solicited estimates of the financial impact of firm-identified material climate risks have no apparent relevance to equity market participants. On the other hand, given that the data being furnished to the CDP is strewn with errors (some easily identifiable, others perhaps less so), that the CDP seems to engage in very minimal validation of the data, and that the CDP expressly does not guarantee its reliability, perhaps it is reasonable that, despite the conceptual soundness of the TCFD framework itself, market participants deem the data being disclosed to the CDP under this framework to lack reliability. Alternatively, investors may consider the estimates to be reliable but the likelihood or timing of their occurrence to be too remote to materially impact firm value. Yet another alternative explanation is that market participants are either simply inattentive to, or don't understand, the TCFD disclosures. Considering that our sample consists of large publicly-traded firms from advanced economies (i.e., the most likely setting for the assumption of equity market efficiency to hold), this explanation might seem improbable. Nevertheless, it is consistent with anecdotal claims made by some of the most influential players in the global capital markets, as well as with recent academic survey evidence, that the TCFD reporting framework is being ignored by investors and that climate risk is generally being under- (or not) priced.

## 5.7 Conclusion

The TCFD framework is purported to be the “gold standard” for corporate climate risk reporting and is poised to become mandatory in numerous jurisdictions, yet to the best of our knowledge there is no prior large sample evidence related to the TCFD-compliant disclosures that firms have been submitting to the CDP since the framework’s introduction. Ours is thus the first study to contribute insights related to these widely touted disclosures that have the backing of many of the most prominent voices in the global capital markets.

Our investigations reveal that the TCFD-compliant financial impact disclosures are riddled with errors. The CDP is the single authoritative organization with whom this data is currently being filed (although nothing precludes firms from additionally or alternatively disclosing it elsewhere), they have a standardized online template for gathering the data, it is a significant resource-consuming effort for firms to complete the survey questionnaire (i.e., responding firms must be motivated as they are making a costly decision to respond and disclose the financial impacts and other data to the CDP), approximately 53% of firms providing financial impact estimates indicate that their climate-related information beyond carbon emissions data is subject to (costly) third party assurance, and yet despite all of this we estimate that a *minimum* of 7% of the financial impact estimates in the CDP database are erroneous. As such, the TCFD-related financial impacts data purveyed by the CDP is not suitable for use in quantitative investment strategies or any other large sample based policy- or decision-making contexts. Even after a detailed review of each entry, only the most egregious financial impact errors may be identifiable, and these may not be easily correctible if the information has not been publicly disclosed through other channels (and in an accessible language).

Our analyses of the usable data focus on a global sample of firms from advanced economies plus South Africa. Using data from 2018-2020, the three years for which TCFD-compliant disclosures are available, we document that the determinants of firms' decisions to respond to the CDP questionnaire, to disclose TCFD-compliant physical and transition risks, and to provide TCFD-solicited estimates of the financial impacts of climate risk, are generally similar to previously documented determinants of other corporate climate-related disclosures (e.g., such as carbon emissions). Specifically, larger firms, those with a larger institutional shareholder base, firms that are more tangible-asset intensive, and those evincing other indicators of their commitment to sustainability, including their overall environmental performance, are all more likely to respond to the CDP and to provide the solicited TCFD-compliant disclosures.

The results from our value-relevance tests are somewhat more surprising, especially in light of the very vocal and unanimous support being expressed for the TCFD reporting framework by influential capital markets participants and regulators around the world. We find that the number of firm-disclosed transition risks is reliably negatively associated with Tobin's Q, consistent with the market treating these as legitimate threats to the firm's business model and future prospects (i.e., as an unrecorded liability or unrecognized asset impairment). However, the physical risks identified by the firm as material are generally not associated with share prices, except in the first year of TCFD-compliant reporting when they were apparently being priced as a positive signal. Company-provided estimates of the financial impacts of their identified climate risks are not associated with market value in any one year, nor when pooled across time, and contrary to prior results in the general CSR literature, third party assurance does not enhance the value-relevance of

TCFD-compliant climate risk disclosures. All of our reported results are robust to battery of additional robustness checks.

In summary, the CDP-provided TCFD disclosures leave much to be desired in terms of data integrity, and market values exhibit only a modest association with one aspect of TCFD disclosures, the total number of transition risks disclosed by the firm. We conclude that investors don't consider physical risk disclosures or the firm's estimates of the financial impacts of climate risk to represent credible, material, imminent threats to firm prospects, that investors don't understand or fully process the information contained in the disclosures, and/or that investors are simply inattentive to the TCFD disclosures. While the latter explanation seems improbable in efficient capital markets, particularly for our sample of relatively large firms from advanced economies, it is nevertheless consistent with widespread anecdotal accounts, as well as practitioner and academic survey evidence. Although caution should be exercised when attempting to draw inferences about proposed *mandatory* TCFD disclosures on the basis of empirical evidence derived from their *voluntary* provision (Christensen et al., 2021), our findings should nevertheless be informative to policy makers and regulators, as well as to investors who are apparently ignoring potentially materially information.

## 5.8 Appendix Chapter 5

### 5.8.1 Appendix A: Description of Sample Selection Procedure

In order to model the voluntary reporting decisions, we require a sample of firms that are expected to have been *invited* to respond to the CDP survey, not just those who have actually replied. Although the CDP's corporate invitation list is not consistently disclosed, we could access the list of companies that the CDP requested to respond to the climate change questionnaire in 2019 and 2021. The former is outlined in the document *CDP's List of Official Samples 2019* (link) and the latter is disclosed on the CDP website (link). The CDP requested 6,100 companies to respond to the Climate Change Questionnaire in 2019 and 6,900 companies were invited to respond in 2021. Focusing on companies that were included in *both* the 2019 and 2021 list, we then applied our sampling criteria to the resulting pool of companies to construct our final sample. We used Refinitiv's EIKON database to implement the screening criteria outlined below.

Our sample determination process is summarized in Table 5.1 below. We began by selecting companies headquartered in advanced economies plus South Africa. The former were identified based upon the listing of advanced economies provided by the IMF (International Monetary Fund, 2020b). We included South Africa in our sampling frame because integrated reporting has been mandatory for firms listed on the Johannesburg Stock Exchange for more than 10 years, which has led to an unusually high rate of climate risk disclosure for companies headquartered in that country. This yielded an initial sample of 4,749 firms. We added 89 companies from these geographies that were not specifically invited to the CDP Climate Change questionnaire but that nonetheless voluntarily submitted at least one response in the period 2018-2020. We removed 301 companies that were no longer publicly listed as of May 21st, 2021, 531 companies operating in the financial sector, and we lose 150 companies due to missing data, resulting in a final sample of 3,856 firms.

**Table 5.1: Sample Determination**

| Sampling Step | Number of Firms |
|---|---|
| Companies from advanced economies & South Africa requested to respond to CDP Climate Change Questionnaire in 2019 and 2021 | 4,749 |
| Companies from Advanced Economies & South Africa that responded to CDP Climate Change Questionnaire without request | +89 |
| Private companies | -301 |
| Financial firms (based upon GICS classification) | -531 |
| Missing data | -150 |
| Number of sample firms | 3,856 |

### 5.8.2 Appendix B: Variable Definitions

**Table 5.2: Variable Definitions**

| Variable | Definition |
|---|---|
| Analysts Follow | Number of sell-side analysts covering the firm. |
| Assets | Total assets of the firm (in $ million). |
| Attest | Indicator variable that equals one if the firm's response to the CDP questionnaire indicates that climate-related information other than carbon emissions has been verified by an independent third party. |
| Block | Indicator variable that equals one if the firm has a shareholder owning 5% or more of the common stock, and zero otherwise |
| BTM | Book-to-market ratio calculated as book value of common equity divided by market value |
| CapEx | Capital intensity calculated as capital expenditures divided by total assets. |
| Cash/Assets | Cash and short-term investments divided by total assets. |
| CDP | Indicator variable that equals one if a firm responds to the CDP questionnaire in given year |
| ClimateRisk | The total number of transition and physical climate risks disclosed by the firm. |
| CO2eRank | The firm's sector decile ranking on the basis of CO2 emissions intensity (i.e., CO2 emissions scaled by sales). |
| CR | Indicator variable that equals one if a firm provides climate risk related information in its response to the CDP questionnaire. |
| EMS | Indicator variable that equals one if a firm has an environmental management system with ISO 14001 certification. |

| | |
|---|---|
| EnvScore | Environmental pillar score retrieved from Refinitiv EIKON database: “The environmental pillar measures a company’s impact on living and non-living natural system, including the air, land and water, as well as complete ecosystems. It reflects how well a company uses best management practices to avoid environmental risks and capitalize on environmental opportunities in order to generate long-term shareholder value.” |
| FI | Indicator variable that equals one if a firm provides information related to the financial impacts of climate risks in its response to the CDP questionnaire. |
| FinImpact | Financial impact estimates of climate risks divided by sales. |
| IMR CR | Inverse Mills ratio calculated from the first stage probit regression modeling firms’ decisions to disclose climate risks. |
| IMR FI | Inverse Mills ratio calculated from the first stage probit regression modeling firms’ decisions to disclose estimates of the financial impacts of climate risks. |
| IndepDir | Ratio of independent directors in relation to the total number of directors on the board. Expressed as percentage. |
| industry | Indicators for each of the 10 GICS sector classifications excluding the financial sector. |
| InstHigh | Indicator that equals one for firms with higher than median institutional ownership. |
| InstOwn | Percentage of traded shares held by institutional investors. Truncated at 100%. Shares held by institutional investors as percentage of total shares outstanding. Truncated at 100%. Set to zero if missing. |
| IntangStock | Stock of R&D+⅓*SG&A investments scaled by adjusted total assets using 5-year amortization. For example, RD&SGAstock for fiscal 2019 = (FY2019 (R&D+⅓SGA)*100% + FY2018 (R&D+⅓SGA)*80% + FY2017 (R&D+⅓SGA)*60% + FY2016 (R&D+⅓SGA)*40% + FY2015 (R&D+⅓SGA)*20%) divided by total assets adjusted to include remaining notionally capitalized intangibles investments. |
| LEV | Leverage calculated as long-term debt divided by total assets. |
| logCO2e | Natural logarithm of (1+ CO2e/Sales), where CO2e is emission intensity calculated as the sum of scope 1 and scope 2 emissions (tons CO2) divided by sales. |
| logSales | Natural logarithm of sales. |
| Market Cap | Market capitalization of the firm (in $ million). |
| PhysRisk | The number of physical climate risks disclosed by the firm. |
| Q | Tobins Q calculated as (total assets + market value of equity - book value of equity) / total assets. |
| R&D/Sales | R&D expenses divided by sales. |
| region | Indicators capturing the firm’s headquarters by country and/or region (*region*) using the following eight classifications: Canada, US, UK, EU+4 (Iceland, Israel, Norway, Switzerland), Australia, Japan + South Korea, South Africa, and HK+Taiwan+Singapore+Macau. |
| ROA | Return on assets calculated as income after taxes divided by total assets. Expressed as percentage. |
| Sales | Total sales of the firm (in $ million) |
| SalesGrowth | Three-year annualized average sales growth. |

| | |
|---|---|
| SGA/Sales | Selling, General & Administrative expenses divided by sales. |
| SustCommittee | Indicator variable that equals one if a firm has a CSR committee or team at board level. |
| SustReport | Indicator variable that equals one if a firm publishes a sustainability report or a section in its annual report on sustainability. |
| TransnRisk | The number of transition climate risks disclosed by the firm. |
| UNsign | Indicator variable that equals one if a firm is a signatory of the UN Global Compact. |

### 5.8.3 Appendix C: Figures and Tables

**Figure 5.1: Number of Problematic Climate Risk Financial Impact Disclosures**

Figure 5.1 presents the number of problematic climate risk financial impact disclosures, of which there may be several per firm per year (i.e., on average, companies disclosing financial impact estimates provided information related to 3.5 climate risks per year). The problematic disclosures are clustered into six categories: **(1) Entity**: Respondent replied at the wrong level of aggregation, e.g., they reported on a particular process or activity rather than at the aggregate company level. **(2) Unit:** Financial impacts were disclosed in the wrong unit, e.g., financial impacts are disclosed as percentages instead of plain numbers in a specified currency. **(3) Aggregate:** The same aggregated financial impact figure was provided for different individual climate risks, e.g. the same financial impact of weather-related events is supplied for both acute and chronic physical climate risks. **(4) Placeholder:** Respondents provided quantitative disclosure as a mere placeholder (e.g. the value 1), stating in the accompanying textual explanation that they were unable to quantitatively assess the financial impacts of climate risks. **(5) Currency:** Financial impacts were disclosed in a different currency then the one in which companies stated they would disclose financial figures throughout the CDP questionnaire. **(6) Double counting:** Financial impacts were disclosed as both point estimates and as minimum/maximum estimates, when companies were asked to provide one or the other.

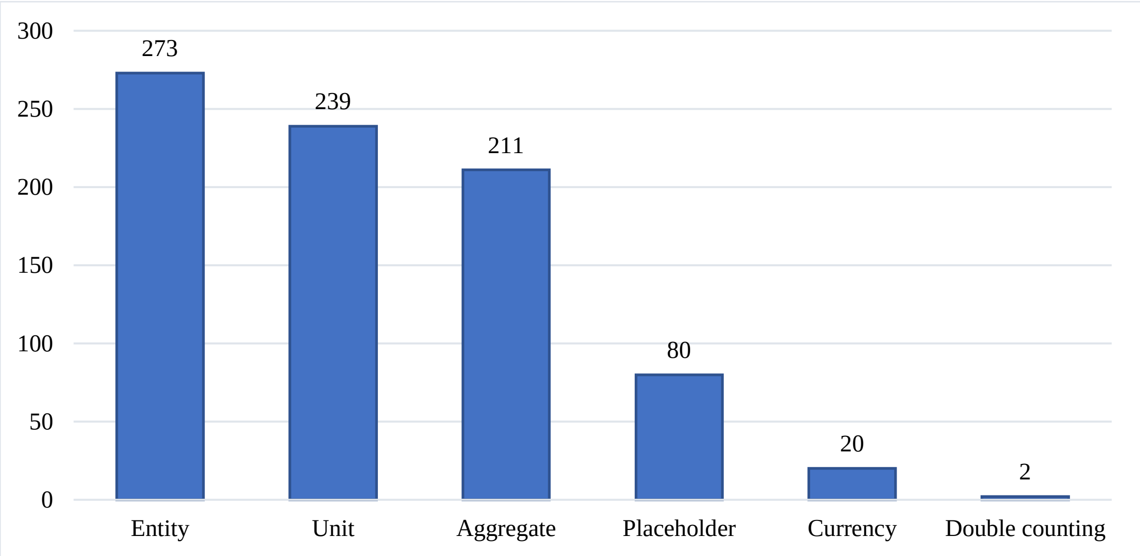

**Table 5.3: Sample Overview**

## Panel A: Number of CDP respondents by country

| | Year | | | |
|---|---|---|---|---|
| Country | 2018 | 2019 | 2020 | Total |
| Australia | 30 | 27 | 28 | 85 |
| Austria | 9 | 10 | 11 | 30 |
| Belgium | 10 | 11 | 13 | 34 |
| Canada | 56 | 67 | 71 | 194 |
| Czech Republic | 0 | 1 | 1 | 2 |
| Denmark | 14 | 16 | 18 | 48 |
| Finland | 29 | 32 | 35 | 96 |
| France | 61 | 70 | 76 | 207 |
| Germany | 55 | 56 | 56 | 167 |
| Greece | 1 | 1 | 1 | 3 |
| Hong Kong | 7 | 13 | 12 | 32 |
| Ireland | 15 | 15 | 21 | 51 |
| Israel | 2 | 2 | 2 | 6 |
| Italy | 24 | 25 | 32 | 81 |
| Japan | 211 | 246 | 281 | 738 |
| Luxembourg | 1 | 2 | 3 | 6 |
| Netherlands | 17 | 21 | 21 | 59 |
| New Zealand | 9 | 12 | 15 | 36 |
| Norway | 23 | 26 | 29 | 78 |
| Portugal | 7 | 8 | 8 | 23 |
| Singapore | 8 | 9 | 9 | 26 |
| South Africa | 46 | 45 | 45 | 136 |
| South Korea | 38 | 38 | 44 | 120 |
| Spain | 28 | 32 | 33 | 93 |
| Sweden | 35 | 45 | 51 | 131 |
| Switzerland | 32 | 38 | 35 | 105 |
| Taiwan | 27 | 28 | 39 | 94 |
| UK | 121 | 132 | 143 | 396 |
| USA | 282 | 328 | 365 | 975 |
| Total | 1198 | 1356 | 1498 | 4052 |

## Panel B: Number of CDP respondents by industry sector

| | Year | | | |
|---|---|---|---|---|
| Sector | 2018 | 2019 | 2020 | Total |
| Communication Services | 65 | 67 | 81 | 213 |
| Consumer Discretionary | 161 | 184 | 206 | 551 |
| Consumer Staples | 122 | 139 | 146 | 407 |
| Energy | 50 | 58 | 66 | 174 |
| Health Care | 83 | 96 | 103 | 282 |
| Industrials | 289 | 324 | 356 | 969 |
| Information Technology | 135 | 159 | 177 | 471 |
| Materials | 157 | 171 | 196 | 524 |
| Real Estate | 54 | 69 | 75 | 198 |
| Utilities | 82 | 89 | 92 | 263 |
| Total | 1198 | 1356 | 1498 | 4052 |

**Panel C: Sample companies by country**

| | Year | | | |
|---|---|---|---|---|
| Country | 2018 | 2019 | 2020 | Total |
| Australia | 158 | 160 | 165 | 483 |
| Austria | 25 | 25 | 25 | 75 |
| Belgium | 64 | 62 | 62 | 188 |
| Canada | 172 | 173 | 177 | 522 |
| Cyprus | 2 | 2 | 2 | 6 |
| Czech Republic | 5 | 5 | 5 | 15 |
| Denmark | 35 | 36 | 37 | 108 |
| Estonia | 8 | 9 | 9 | 26 |
| Finland | 41 | 43 | 43 | 127 |
| France | 226 | 229 | 220 | 675 |
| Germany | 178 | 181 | 184 | 543 |
| Greece | 7 | 6 | 6 | 19 |
| Hong Kong | 102 | 103 | 107 | 312 |
| Iceland | 2 | 2 | 2 | 6 |
| Ireland | 41 | 41 | 44 | 126 |
| Israel | 16 | 16 | 16 | 48 |
| Italy | 68 | 71 | 73 | 212 |
| Japan | 527 | 531 | 533 | 1591 |
| Latvia | 2 | 2 | 2 | 6 |
| Lithuania | 7 | 7 | 7 | 21 |
| Luxembourg | 24 | 27 | 27 | 78 |
| Macau | 3 | 3 | 3 | 9 |
| Malta | 2 | 2 | 2 | 6 |
| Netherlands | 59 | 60 | 59 | 178 |
| New Zealand | 78 | 75 | 81 | 234 |
| Norway | 40 | 43 | 44 | 127 |
| Portugal | 32 | 32 | 30 | 94 |
| Singapore | 36 | 37 | 37 | 110 |
| Slovak Republic | 1 | 1 | 1 | 3 |
| South Africa | 75 | 76 | 77 | 228 |
| South Korea | 202 | 214 | 222 | 638 |
| Spain | 72 | 75 | 74 | 221 |
| Sweden | 102 | 104 | 105 | 311 |
| Switzerland | 112 | 115 | 120 | 347 |
| Taiwan | 107 | 108 | 109 | 324 |
| UK | 336 | 340 | 340 | 1016 |
| USA | 717 | 727 | 735 | 2179 |
| Total | 3684 | 3743 | 3785 | 11212 |

**Panel D: Sample companies by industry sector**

| | Year | | | |
|---|---|---|---|---|
| Sector | 2018 | 2019 | 2020 | Total |
| Communication Services | 217 | 222 | 225 | 664 |
| Consumer Discretionary | 547 | 554 | 559 | 1660 |
| Consumer Staples | 312 | 319 | 320 | 951 |
| Energy | 186 | 191 | 190 | 567 |
| Health Care | 336 | 345 | 350 | 1031 |
| Industrials | 803 | 811 | 813 | 2427 |
| Information Technology | 427 | 433 | 445 | 1305 |
| Materials | 432 | 439 | 447 | 1318 |
| Real Estate | 256 | 258 | 265 | 779 |
| Utilities | 168 | 171 | 171 | 510 |
| Total | 3684 | 3743 | 3785 | 11212 |

**Panel E: CDP response rate by country**

| Country | Year | | |
|---|---|---|---|
| | 2018 | 2019 | 2020 |
| Australia | 18.99 | 16.88 | 16.97 |
| Austria | 36.00 | 40.00 | 44.00 |
| Belgium | 15.63 | 17.74 | 20.97 |
| Canada | 32.56 | 38.73 | 40.11 |
| Cyprus | 0.00 | 0.00 | 0.00 |
| Czech Republic | 0.00 | 20.00 | 20.00 |
| Denmark | 40.00 | 44.44 | 48.65 |
| Estonia | 0.00 | 0.00 | 0.00 |
| Finland | 70.73 | 74.42 | 81.40 |
| France | 26.99 | 30.57 | 34.55 |
| Germany | 30.90 | 30.94 | 30.43 |
| Greece | 14.29 | 16.67 | 16.67 |
| Hong Kong | 6.86 | 12.62 | 11.21 |
| Iceland | 0.00 | 0.00 | 0.00 |
| Ireland | 36.59 | 36.59 | 47.73 |
| Israel | 12.50 | 12.50 | 12.50 |
| Italy | 35.29 | 35.21 | 43.84 |
| Japan | 40.04 | 46.33 | 52.72 |
| Latvia | 0.00 | 0.00 | 0.00 |
| Lithuania | 0.00 | 0.00 | 0.00 |
| Luxembourg | 4.17 | 7.41 | 11.11 |
| Macau | 0.00 | 0.00 | 0.00 |
| Malta | 0.00 | 0.00 | 0.00 |
| Netherlands | 28.81 | 35.00 | 35.59 |
| New Zealand | 11.54 | 16.00 | 18.52 |
| Norway | 57.50 | 60.47 | 65.91 |
| Portugal | 21.88 | 25.00 | 26.67 |
| Singapore | 22.22 | 24.32 | 24.32 |
| Slovak Republic | 0.00 | 0.00 | 0.00 |
| South Africa | 61.33 | 59.21 | 58.44 |
| South Korea | 18.81 | 17.76 | 19.82 |
| Spain | 38.89 | 42.67 | 44.59 |
| Sweden | 34.31 | 43.27 | 48.57 |
| Switzerland | 28.57 | 33.04 | 29.17 |
| Taiwan | 25.23 | 25.93 | 35.78 |
| UK | 36.01 | 38.82 | 42.06 |
| USA | 39.33 | 45.12 | 49.66 |

**Panel F: CDP response rate by sector**

| Sector | Year | | |
|---|---|---|---|
| | 2018 | 2019 | 2020 |
| Communication Services | 29.95 | 30.18 | 36.00 |
| Consumer Discretionary | 29.43 | 33.21 | 36.85 |
| Consumer Staples | 39.10 | 43.57 | 45.63 |
| Energy | 26.88 | 30.37 | 34.74 |
| Health Care | 24.70 | 27.83 | 29.43 |
| Industrials | 35.99 | 39.95 | 43.79 |
| Information Technology | 31.62 | 36.72 | 39.78 |
| Materials | 36.34 | 38.95 | 43.85 |
| Real Estate | 21.09 | 26.74 | 28.30 |
| Utilities | 48.81 | 52.05 | 53.80 |

### Panel G: Climate risk disclosure rate by country

| | Year | | |
|---|---|---|---|
| Country | 2018 | 2019 | 2020 |
| Australia | 13.92 | 14.38 | 12.73 |
| Austria | 36.00 | 36.00 | 40.00 |
| Belgium | 14.06 | 16.13 | 19.35 |
| Canada | 26.74 | 28.90 | 33.90 |
| Cyprus | 0.00 | 0.00 | 0.00 |
| Czech Republic | 0.00 | 20.00 | 20.00 |
| Denmark | 28.57 | 41.67 | 43.24 |
| Estonia | 0.00 | 0.00 | 0.00 |
| Finland | 51.22 | 55.81 | 67.44 |
| France | 23.89 | 26.64 | 29.09 |
| Germany | 19.66 | 21.55 | 21.74 |
| Greece | 14.29 | 16.67 | 16.67 |
| Hong Kong | 6.86 | 9.71 | 11.21 |
| Iceland | 0.00 | 0.00 | 0.00 |
| Ireland | 34.15 | 34.15 | 40.91 |
| Israel | 12.50 | 12.50 | 12.50 |
| Italy | 33.82 | 32.39 | 39.73 |
| Japan | 37.57 | 43.88 | 48.22 |
| Latvia | 0.00 | 0.00 | 0.00 |
| Lithuania | 0.00 | 0.00 | 0.00 |
| Luxembourg | 4.17 | 3.70 | 7.41 |
| Macau | 0.00 | 0.00 | 0.00 |
| Malta | 0.00 | 0.00 | 0.00 |
| Netherlands | 28.81 | 33.33 | 35.59 |
| New Zealand | 11.54 | 16.00 | 16.05 |
| Norway | 52.50 | 51.16 | 59.09 |
| Portugal | 21.88 | 21.88 | 26.67 |
| Singapore | 16.67 | 24.32 | 21.62 |
| Slovak Republic | 0.00 | 0.00 | 0.00 |
| South Africa | 60.00 | 57.89 | 54.55 |
| South Korea | 18.81 | 17.29 | 19.37 |
| Spain | 36.11 | 40.00 | 40.54 |
| Sweden | 25.49 | 32.69 | 40.95 |
| Switzerland | 19.64 | 23.48 | 19.17 |
| Taiwan | 24.30 | 25.93 | 33.94 |
| UK | 29.46 | 33.24 | 36.18 |
| USA | 33.47 | 37.69 | 42.72 |

### Panel H: Climate risk disclosure rate by sector

| | Year | | |
|---|---|---|---|
| Sector | 2018 | 2019 | 2020 |
| Communication Services | 24.42 | 24.77 | 29.33 |
| Consumer Discretionary | 26.69 | 30.51 | 34.17 |
| Consumer Staples | 35.90 | 40.44 | 41.88 |
| Energy | 24.73 | 26.18 | 32.11 |
| Health Care | 19.35 | 22.32 | 22.86 |
| Industrials | 28.89 | 32.68 | 36.41 |
| Information Technology | 25.76 | 29.79 | 31.69 |
| Materials | 32.41 | 34.85 | 39.60 |
| Real Estate | 19.92 | 24.03 | 25.66 |
| Utilities | 47.02 | 49.12 | 53.22 |

**Table 5.4: Descriptive Statistics**

## Panel A: Company Descriptive Statistics (Mean)

| s | Sample | CDP | No CDP | Diff | Climate Risk | No Climate Risk | Diff | Financial Impact | No Financial Impact | Diff |
|---|---|---|---|---|---|---|---|---|---|---|
| Sales | 7330.39 | 13348.28 | 3924.74 | 9423.5*** | 13827.43 | 4367.07 | 9460.4*** | 14369.25 | 5064.88 | 9304.4*** |
| Assets | 11730.15 | 20989.26 | 6490.21 | 14499.0*** | 22070.71 | 7013.78 | 15056.9*** | 23477 | 7949.33 | 15527.7*** |
| Market Cap | 10240.1 | 18391.14 | 5627.24 | 12763.9*** | 18495.68 | 6474.69 | 12021.0*** | 18884.18 | 7457.93 | 11426.3*** |
| ROA | 4.57 | 5.25 | 4.18 | 1.076*** | 5.09 | 4.33 | 0.765*** | 5.05 | 4.41 | 0.634*** |
| CapEx | .04 | .04 | .04 | 0.00223** | .04 | .04 | 0.00357*** | .04 | .04 | 0.00289*** |
| R&D/Sales | .03 | .02 | .04 | -0.0181*** | .02 | .04 | -0.0195*** | .02 | .04 | -0.0176*** |
| SGA/Sales | .22 | .19 | .24 | -0.0517*** | .18 | .24 | -0.0567*** | .19 | .23 | -0.0463*** |
| LEV | .21 | .22 | .2 | 0.0230*** | .23 | .2 | 0.0248*** | .22 | .2 | 0.0154*** |
| Analysts Follow | 10 | 13.33 | 8.11 | 5.219*** | 13.4 | 8.44 | 4.957*** | 13.74 | 8.79 | 4.950*** |
| Number of obs. | 11212 | 4052 | 7160 | | 3512 | 7700 | | 2730 | 8482 | |

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

**Table 5.4**

**Panel B: Regression Descriptive Statistics**

| | Mean | Std. Dev. | min | p25 | Median | p75 | max | N |
|---|---|---|---|---|---|---|---|---|
| Q | 1.974 | 1.759 | .626 | 1.041 | 1.355 | 2.106 | 11.38 | 11212 |
| CDP | .361 | .48 | 0 | 0 | 0 | 1 | 1 | 11212 |
| CR | .313 | .464 | 0 | 0 | 0 | 1 | 1 | 11212 |
| FI | .243 | .429 | 0 | 0 | 0 | 0 | 1 | 11212 |
| TransnRisk | .788 | 1.456 | 0 | 0 | 0 | 1 | 7 | 11212 |
| PhysRisk | .472 | .902 | 0 | 0 | 0 | 1 | 4 | 11212 |
| ClimateRisk | 1.262 | 2.181 | 0 | 0 | 0 | 3 | 10 | 11212 |
| FinImpact | .017 | .07 | 0 | 0 | 0 | 0 | .53 | 11212 |
| logSales | 7.593 | 1.804 | 2.161 | 6.498 | 7.722 | 8.804 | 11.483 | 11212 |
| ROA | 4.566 | 8.02 | -31.085 | 1.974 | 4.524 | 7.93 | 28.537 | 11212 |
| BTM | .629 | .538 | -.155 | .255 | .49 | .851 | 2.912 | 11212 |
| LEV | .208 | .164 | 0 | .071 | .186 | .315 | .699 | 11212 |
| CapEx | .042 | .039 | 0 | .015 | .032 | .057 | .21 | 11212 |
| SalesGrowth | 9.617 | 20.07 | -27.748 | 1.34 | 6.038 | 12.542 | 136.353 | 11212 |
| Cash/Assets | .134 | .14 | .001 | .039 | .089 | .174 | .721 | 11212 |
| IntangStock | .191 | .193 | 0 | .049 | .136 | .272 | .971 | 11212 |
| InstOwn | 61.616 | 24.733 | 2.631 | 44.943 | 63.559 | 81.108 | 100 | 11212 |
| Block | .958 | .201 | 0 | 1 | 1 | 1 | 1 | 11212 |
| IndepDir | 46.011 | 34.382 | 0 | 0 | 50 | 77.778 | 100 | 11212 |
| SustCommittee | .496 | .5 | 0 | 0 | 0 | 1 | 1 | 11212 |
| EMS | .401 | .49 | 0 | 0 | 0 | 1 | 1 | 11212 |
| UNsign | .166 | .372 | 0 | 0 | 0 | 0 | 1 | 11212 |
| SustReport | .593 | .491 | 0 | 0 | 1 | 1 | 1 | 11212 |
| Attest | .153 | .36 | 0 | 0 | 0 | 0 | 1 | 11212 |

All variables are defined in detail in Appendix B. Institutional ownership (InstOwn) is truncated at 100% and all other continuous variables are winsorized at the 1% and 99% level.

**Table 5.5: Correlation Matrix**

## Panel A: Disclosure Choice Model

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) CDP | 1.00 | | | | | | | | | | | | | | | |
| (2) CR | 0.90* | 1.00 | | | | | | | | | | | | | | |
| (3) FI | 0.75* | 0.84* | 1.00 | | | | | | | | | | | | | |
| (4) logSales | 0.43* | 0.41* | 0.36* | 1.00 | | | | | | | | | | | | |
| (5) ROA | 0.06* | 0.04* | 0.03* | 0.17* | 1.00 | | | | | | | | | | | |
| (6) BTM | -0.02* | 0.01 | 0.03* | 0.03* | -0.21* | 1.00 | | | | | | | | | | |
| (7) LEV | 0.07* | 0.07* | 0.04* | 0.12* | -0.13* | -0.09* | 1.00 | | | | | | | | | |
| (8) CapEx | 0.03* | 0.04* | 0.03* | 0.04* | 0.03* | -0.02* | 0.08* | 1.00 | | | | | | | | |
| (9) IntangStock | -0.04* | -0.06* | -0.05* | -0.12* | -0.02* | -0.29* | -0.23* | -0.07* | 1.00 | | | | | | | |
| (10) InstOwn | 0.13* | 0.11* | 0.06* | 0.22* | 0.07* | -0.13* | 0.20* | 0.01 | -0.06* | 1.00 | | | | | | |
| (11) Block | 0.01 | -0.00 | -0.01 | -0.01 | 0.04* | -0.04* | -0.01 | -0.01 | 0.02* | 0.17* | 1.00 | | | | | |
| (12) IndepDir | 0.25* | 0.20* | 0.14* | 0.33* | 0.05* | -0.16* | 0.24* | 0.04* | -0.07* | 0.34* | 0.05* | 1.00 | | | | |
| (13) SustCommittee | 0.42* | 0.41* | 0.38* | 0.43* | 0.05* | 0.04* | 0.09* | 0.07* | -0.13* | 0.09* | 0.00 | 0.42* | 1.00 | | | |
| (14) EMS | 0.35* | 0.33* | 0.31* | 0.39* | 0.06* | 0.05* | -0.03* | 0.02 | -0.07* | 0.04* | -0.00 | 0.26* | 0.50* | 1.00 | | |
| (15) UNsign | 0.34* | 0.32* | 0.30* | 0.32* | 0.02* | 0.00 | 0.01 | -0.00 | -0.02* | -0.01 | -0.00 | 0.19* | 0.34* | 0.36* | 1.00 | |
| (16) SustReport | 0.41* | 0.38* | 0.34* | 0.42* | 0.09* | -0.00 | 0.10* | 0.05* | -0.11* | 0.12* | 0.03* | 0.48* | 0.69* | 0.55* | 0.34* | 1.00 |

* p<0.05

## Panel B: Value Relevance Model

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Q | 1.00 | | | | | | | | | | | | | | |
| (2) CDP | -0.09* | 1.00 | | | | | | | | | | | | | |
| (3) CR | -0.12* | 0.89* | 1.00 | | | | | | | | | | | | |
| (4) FI | -0.12* | 0.74* | 0.83* | 1.00 | | | | | | | | | | | |
| (5) TransnRisk | -0.12* | 0.70* | 0.79* | 0.67* | 1.00 | | | | | | | | | | |
| (6) PhysRisk | -0.09* | 0.68* | 0.76* | 0.65* | 0.67* | 1.00 | | | | | | | | | |
| (7) FinImpact | -0.07* | 0.30* | 0.33* | 0.40* | 0.33* | 0.30* | 1.00 | | | | | | | | |
| (8) logSales | -0.22* | 0.39* | 0.38* | 0.34* | 0.30* | 0.27* | 0.10* | 1.00 | | | | | | | |
| (9) ROA | 0.28* | 0.04* | 0.02* | 0.01 | 0.00 | 0.02 | -0.02* | 0.08* | 1.00 | | | | | | |
| (10) LEV | -0.12* | 0.04* | 0.04* | 0.01 | 0.03* | 0.05* | -0.00 | 0.07* | -0.16* | 1.00 | | | | | |
| (11) IntangStock | 0.38* | -0.02 | -0.05* | -0.04* | -0.05* | -0.07* | -0.03* | -0.05* | 0.07* | -0.23* | 1.00 | | | | |
| (12) CapEx | -0.05* | 0.02 | 0.04* | 0.03* | 0.03* | 0.03* | 0.02* | 0.02 | 0.01 | 0.07* | -0.07* | 1.00 | | | |
| (13) SalesGrowth | 0.25* | -0.16* | -0.15* | -0.14* | -0.13* | -0.13* | -0.04* | -0.20* | -0.02 | -0.04* | 0.01 | 0.01 | 1.00 | | |
| (14) Cash/Assets | 0.41* | -0.12* | -0.13* | -0.10* | -0.12* | -0.12* | -0.05* | -0.17* | 0.05* | -0.34* | 0.36* | -0.12* | 0.19* | 1.00 | |
| (15) Attest | -0.09* | 0.55* | 0.55* | 0.58* | 0.47* | 0.46* | 0.24* | 0.32* | 0.01 | 0.02 | -0.02 | -0.00 | -0.10* | -0.08* | 1.00 |

* p<0.05

### Table 5.6: CDP Questionnaire Disclosure Decision

Table 5.6 presents the results from probit regressions examining the determinants of firms' decisions to respond to the CDP questionnaire. In column (1), we regress *CDP* on financial, ownership, and independent director variables; in column (2) we add industry and region fixed effects; in column (3) we add variables capturing the firm's commitment to sustainability. Robust standard errors are reported in parentheses. Institutional ownership (*InstOwn*) is truncated at 100 and all other continuous variables are winsorized at the 1% and 99% levels. All variables are defined in detail in Appendix B.

| | (1) | (2) | (3) |
|---|---|---|---|
| VARIABLES | CDP | CDP | CDP |
| logSales | 0.359*** | 0.417*** | 0.270*** |
| | (0.0138) | (0.0169) | (0.0185) |
| ROA | 0.00336* | 0.00459** | 0.00511*** |
| | (0.00177) | (0.00184) | (0.00175) |
| BTM | -3.41e-05 | -0.0180 | 0.00125 |
| | (0.0374) | (0.0387) | (0.0398) |
| LEV | -0.0459 | 0.0733 | 0.109 |
| | (0.130) | (0.126) | (0.131) |
| CapEx | 0.500 | 1.304*** | 0.548 |
| | (0.383) | (0.402) | (0.387) |
| IntangStock | 0.0754 | 0.173* | 0.208** |
| | (0.0881) | (0.0977) | (0.0974) |
| InstOwn | 0.000986 | 0.00381*** | 0.00356*** |
| | (0.00115) | (0.00109) | (0.00105) |
| Block | 0.0111 | 0.000210 | -0.0379 |
| | (0.0819) | (0.0895) | (0.0878) |
| IndepDir | 0.00536*** | 0.00675*** | -0.00222** |
| | (0.000924) | (0.00131) | (0.00112) |
| SustCommittee | | | 0.462*** |
| | | | (0.0468) |
| EMS | | | 0.175*** |
| | | | (0.0564) |
| UNsign | | | 0.455*** |
| | | | (0.0478) |
| SustReport | | | 0.528*** |
| | | | (0.0684) |
| Industry controls | no | yes | yes |
| Region controls | no | yes | yes |
| Constant | -3.547*** | -4.936*** | -3.483*** |
| | (0.149) | (0.262) | (0.198) |
| Log likelihood | -6057 | -5780 | -5292 |
| Wald $\chi^2$ | 864.2 | 1016 | 1507 |
| McFadden $R^2$ | 0.174 | 0.212 | 0.278 |
| % of correct predictions | 68.96 | 70.99 | 75.35 |
| Observations | 11,212 | 11,212 | 11,212 |

Robust standard errors in parentheses. Standard errors clustered by firm and year.
Cutoff point for determining percentage of correct predictions is 0.36.
*** p<0.01, ** p<0.05, * p<0.1

**Table 5.7: Climate Risk Disclosure Decision**

Table 5.7 presents the results from probit regressions examining the determinants of firms' decisions to provide information related to climate risks. In column (1), we regress *CR* on financial, ownership, and independent director variables; in column (2) we add industry and region fixed effects; in column (3) we add variables capturing the firm's commitment to sustainability. Robust standard errors are reported in parentheses. Institutional ownership (*InstOwn*) is truncated at 100 and all other continuous variables are winsorized at the 1% and 99% levels. All variables are defined in detail in Appendix B.

| VARIABLES | (1)<br>CR | (2)<br>CR | (3)<br>CR |
|---|---|---|---|
| logSales | 0.363*** | 0.414*** | 0.270*** |
| | (0.0126) | (0.0142) | (0.0188) |
| ROA | 0.00113 | 0.00216 | 0.00266 |
| | (0.00192) | (0.00207) | (0.00212) |
| BTM | 0.0481 | 0.0117 | 0.0339 |
| | (0.0426) | (0.0419) | (0.0448) |
| LEV | 0.0265 | 0.144 | 0.198* |
| | (0.105) | (0.109) | (0.109) |
| CapEx | 1.204*** | 1.811*** | 1.161*** |
| | (0.383) | (0.435) | (0.418) |
| IntangStock | -0.148 | -0.00895 | 0.00825 |
| | (0.114) | (0.135) | (0.137) |
| InstOwn | 0.00116 | 0.00387*** | 0.00358*** |
| | (0.00102) | (0.00105) | (0.000982) |
| Block | -0.0334 | -0.0595 | -0.0972 |
| | (0.0819) | (0.0854) | (0.0927) |
| IndepDir | 0.00355*** | 0.00516*** | -0.00398*** |
| | (0.000696) | (0.000961) | (0.000904) |
| SustCommittee | | | 0.514*** |
| | | | (0.0498) |
| EMS | | | 0.219*** |
| | | | (0.0678) |
| UNsign | | | 0.401*** |
| | | | (0.0454) |
| SustReport | | | 0.473*** |
| | | | (0.0682) |
| Industry controls | no | yes | yes |
| Region controls | no | yes | yes |
| Constant | -3.638*** | -4.995*** | -3.581*** |
| | (0.165) | (0.235) | (0.202) |
| Log likelihood | -5812 | -5560 | -5091 |
| Wald $\chi^2$ | 769.1 | 903.1 | 1374 |
| McFadden $R^2$ | 0.166 | 0.202 | 0.270 |
| % of correct predictions | 68.36 | 70.39 | 74.77 |
| Observations | 11,212 | 11,212 | 11,212 |

Robust standard errors in parentheses. Standard errors clustered by firm and year.
Cutoff point for determining percentage of correct predictions is 0.31.
*** p<0.01, ** p<0.05, * p<0.1

**Table 5.8: Financial Impact Disclosure Decision**

Table 5.8 presents the results from probit regressions examining the determinants of firms' decisions to provide quantitative estimates related to the financial impacts of climate risks. In column (1), we regress *FI* on financial, ownership, and independent director variables; in column (2) we add industry and region fixed effects; in column (3) we add variables capturing the firm's commitment to sustainability. Robust standard errors are reported in parentheses. Institutional ownership (*InstOwn*) is truncated at 100 and all other continuous variables are winsorized at the 1% and 99% levels. All variables are defined in detail in Appendix B.

| | (1) | (2) | (3) |
|---|---|---|---|
| VARIABLES | FI | FI | FI |
| logSales | 0.343*** | 0.411*** | 0.278*** |
| | (0.0121) | (0.0138) | (0.0189) |
| ROA | 0.00122 | 0.00192 | 0.00217 |
| | (0.00212) | (0.00260) | (0.00231) |
| BTM | 0.0883* | 0.0228 | 0.0419 |
| | (0.0485) | (0.0458) | (0.0488) |
| LEV | -0.0372 | 0.0879 | 0.129 |
| | (0.112) | (0.130) | (0.126) |
| CapEx | 0.907* | 1.780*** | 1.153** |
| | (0.507) | (0.522) | (0.489) |
| IntangStock | -0.0849 | 0.117 | 0.142 |
| | (0.153) | (0.170) | (0.163) |
| InstOwn | 0.000217 | 0.00397*** | 0.00371*** |
| | (0.000819) | (0.000867) | (0.000880) |
| Block | -0.0160 | -0.0658 | -0.0938 |
| | (0.0905) | (0.0922) | (0.0968) |
| IndepDir | 0.00181*** | 0.00416*** | -0.00416*** |
| | (0.000616) | (0.000933) | (0.000893) |
| SustCommittee | | | 0.566*** |
| | | | (0.0415) |
| EMS | | | 0.205*** |
| | | | (0.0540) |
| UNsign | | | 0.331*** |
| | | | (0.0527) |
| SustReport | | | 0.359*** |
| | | | (0.0876) |
| Industry controls | no | yes | yes |
| Region controls | no | yes | yes |
| Constant | -3.596*** | -5.287*** | -4.034*** |
| | (0.153) | (0.248) | (0.211) |
| Log likelihood | -5342 | -5012 | -4645 |
| Wald $\chi^2$ | 607.3 | 762.5 | 1149 |
| McFadden $R^2$ | 0.142 | 0.195 | 0.254 |
| % of correct predictions | 66.78 | 70.49 | 73.50 |
| Observations | 11,212 | 11,212 | 11,212 |

Robust standard errors in parentheses. Standard errors clustered by firm and year.
Cutoff point for determining percentage of correct predictions is 0.24.
*** p<0.01, ** p<0.05, * p<0.1

**Table 5.9: Disclosure Choice Model Controlling for Environmental Performance**

Table 5.9 presents results from the fully specified disclosure choice model regressions using the available observations after controlling for carbon emissions and the overall environmental performance score, respectively. In Panel A, carbon emissions are measured using the firm's sector decile ranking of $CO_2e$ scaled by revenues (*CO2eRank*). Panel B presents the results using the natural log of $CO_2e$ emissions to control for carbon emissions performance. Panel C presents the results from each of the fully specified decision models after including Refinitiv's environmental pillar score as the proxy for the firm's environmental performance. Robust standard errors are reported in parentheses. Institutional ownership (*InstOwn*) is truncated at 100 and all other continuous variables are winsorized at the 1% and 99% levels. All variables are defined in detail in Appendix B.

## Panel A: Carbon emissions measured as *CO2eRank*

| VARIABLES | (1)<br>CDP | (2)<br>CR | (3)<br>FI |
|---|---|---|---|
| logSales | 0.254*** | 0.253*** | 0.265*** |
| | (0.0153) | (0.0155) | (0.0165) |
| ROA | 0.00754*** | 0.00614** | 0.00560** |
| | (0.00255) | (0.00293) | (0.00253) |
| BTM | -0.0611 | -0.0226 | -0.00349 |
| | (0.0415) | (0.0467) | (0.0570) |
| LEV | 0.116 | 0.196 | 0.115 |
| | (0.153) | (0.124) | (0.149) |
| CapEx | 0.622 | 1.040** | 1.018 |
| | (0.471) | (0.507) | (0.629) |
| IntangStock | 0.0685 | -0.194 | -0.00911 |
| | (0.110) | (0.139) | (0.173) |
| InstOwn | 0.00292** | 0.00299*** | 0.00314*** |
| | (0.00139) | (0.00110) | (0.00117) |
| Block | -0.0821 | -0.151 | -0.160 |
| | (0.111) | (0.139) | (0.121) |
| IndepDir | 0.00407*** | 0.00193* | 0.000563 |
| | (0.000979) | (0.00113) | (0.00106) |
| SustCommittee | 0.527*** | 0.581*** | 0.620*** |
| | (0.0528) | (0.0489) | (0.0451) |
| EMS | 0.283*** | 0.315*** | 0.268*** |
| | (0.0535) | (0.0725) | (0.0653) |
| CO2eRank | 0.00426 | 0.0134* | 0.0153 |
| | (0.00800) | (0.00697) | (0.0117) |
| UNsign | 0.428*** | 0.375*** | 0.314*** |
| | (0.0592) | (0.0511) | (0.0612) |
| SustReport | 0.815*** | 0.772*** | 0.631*** |
| | (0.0517) | (0.0495) | (0.0693) |
| Industry controls | yes | yes | yes |
| Region controls | yes | yes | yes |
| Constant | -3.981*** | -4.123*** | -4.524*** |
| | (0.218) | (0.245) | (0.249) |
| Log likelihood | -4249 | -4152 | -3886 |
| Wald $\chi^2$ | 1157 | 1100 | 898.2 |
| McFadden $R^2$ | 0.265 | 0.259 | 0.242 |
| % of correct predictions | 74.12 | 73.37 | 70.86 |
| Observations | 8,444 | 8,444 | 8,444 |

Robust standard errors in parentheses. Standard errors clustered by firm and year.
Cutoff point for determining percentage of correct predictions is 0.43 in column (1), 0.37 in column (2), and 0.29 in column (3).
*** p<0.01, ** p<0.05, * p<0.1

**Table 5.9: Disclosure Choice Model Controlling for Environmental Performance**

**Panel B: Carbon emissions measured as *logCO2e***

| VARIABLES | (1) CDP | (2) CR | (3) FI |
|---|---|---|---|
| logSales | 0.254*** | 0.252*** | 0.265*** |
| | (0.0153) | (0.0156) | (0.0164) |
| ROA | 0.00751*** | 0.00618** | 0.00564** |
| | (0.00250) | (0.00290) | (0.00250) |
| BTM | -0.0608 | -0.0278 | -0.0108 |
| | (0.0411) | (0.0449) | (0.0553) |
| LEV | 0.117 | 0.181 | 0.0934 |
| | (0.159) | (0.124) | (0.144) |
| CapEx | 0.629 | 0.880* | 0.792 |
| | (0.465) | (0.496) | (0.682) |
| IntangStock | 0.0675 | -0.181 | 0.00926 |
| | (0.109) | (0.141) | (0.178) |
| InstOwn | 0.00292** | 0.00299*** | 0.00313*** |
| | (0.00139) | (0.00110) | (0.00117) |
| Block | -0.0821 | -0.148 | -0.157 |
| | (0.111) | (0.140) | (0.122) |
| IndepDir | 0.00407*** | 0.00192* | 0.000548 |
| | (0.000979) | (0.00113) | (0.00107) |
| SustCommittee | 0.527*** | 0.578*** | 0.615*** |
| | (0.0527) | (0.0485) | (0.0456) |
| EMS | 0.284*** | 0.315*** | 0.268*** |
| | (0.0548) | (0.0736) | (0.0657) |
| logCO2e | 0.00750 | 0.0388*** | 0.0469** |
| | (0.0132) | (0.0135) | (0.0211) |
| UNsign | 0.428*** | 0.375*** | 0.314*** |
| | (0.0597) | (0.0516) | (0.0618) |
| SustReport | 0.815*** | 0.771*** | 0.629*** |
| | (0.0518) | (0.0496) | (0.0689) |
| Industry controls | yes | yes | yes |
| Region controls | yes | yes | yes |
| Constant | -3.976*** | -4.135*** | -4.542*** |
| | (0.216) | (0.249) | (0.254) |
| Log likelihood | -4249 | -4150 | -3882 |
| Wald $\chi^2$ | 1157 | 1103 | 900.5 |
| McFadden $R^2$ | 0.265 | 0.259 | 0.242 |
| % of correct predictions | 74.10 | 73.39 | 71.34 |
| Observations | 8,444 | 8,444 | 8,444 |

Robust standard errors in parentheses. Standard errors clustered by firm and year.
Cutoff point for determining percentage of correct predictions is 0.43 in column (1), 0.37 in column (2), and 0.29 in column (3).
*** p<0.01, ** p<0.05, * p<0.1

**Table 5.9: Disclosure Choice Model Controlling for Environmental Performance**

**Panel C: Environmental pillar score (*EnvScore*)**

| VARIABLES | (1)<br>CDP | (2)<br>CR | (3)<br>FI |
|---|---|---|---|
| logSales | 0.168*** | 0.166*** | 0.180*** |
| | (0.0167) | (0.0176) | (0.0168) |
| ROA | 0.00669*** | 0.00481* | 0.00425 |
| | (0.00216) | (0.00257) | (0.00269) |
| BTM | -0.0689 | -0.0214 | 0.00298 |
| | (0.0438) | (0.0453) | (0.0489) |
| LEV | 0.124 | 0.231* | 0.161 |
| | (0.164) | (0.125) | (0.144) |
| CapEx | 0.552 | 1.200** | 1.204* |
| | (0.452) | (0.497) | (0.665) |
| IntangStock | -0.00915 | -0.299** | -0.0962 |
| | (0.106) | (0.135) | (0.182) |
| InstOwn | 0.00271** | 0.00286*** | 0.00320*** |
| | (0.00138) | (0.00109) | (0.00116) |
| Block | -0.0762 | -0.152 | -0.163 |
| | (0.112) | (0.139) | (0.126) |
| IndepDir | 0.00323*** | 0.00111 | -0.000293 |
| | (0.000961) | (0.00120) | (0.00116) |
| SustCommittee | 0.315*** | 0.371*** | 0.412*** |
| | (0.0503) | (0.0480) | (0.0480) |
| EMS | 0.181*** | 0.223*** | 0.176*** |
| | (0.0535) | (0.0699) | (0.0669) |
| EnvScore | 0.0174*** | 0.0173*** | 0.0175*** |
| | (0.000962) | (0.00100) | (0.00111) |
| UNsign | 0.311*** | 0.255*** | 0.190*** |
| | (0.0538) | (0.0476) | (0.0555) |
| SustReport | 0.406*** | 0.367*** | 0.204** |
| | (0.0620) | (0.0565) | (0.0917) |
| Industry controls | yes | yes | yes |
| Region controls | yes | yes | yes |
| Constant | -3.375*** | -3.490*** | -3.925*** |
| | (0.217) | (0.259) | (0.279) |
| Log likelihood | -4090 | -3999 | -3739 |
| Wald $\chi^2$ | 1260 | 1196 | 993.6 |
| McFadden $R^2$ | 0.299 | 0.291 | 0.275 |
| % of correct predictions | 75.70 | 75.01 | 73.68 |
| Observations | 8,530 | 8,530 | 8,530 |

Robust standard errors in parentheses. Standard errors clustered by firm and year.
Cutoff point for determining percentage of correct predictions is 0.43 in column (1), 0.37 in column (2), and 0.29 in column (3).
*** p<0.01, ** p<0.05, * p<0.1

**Table 5.10: Value Relevance of Climate-related Disclosure Decision**

Table 5.10 presents the results from regressing Tobin's Q on firms' decisions to provide climate-related disclosures. In column (1) we regress *Q* on firms' decision to respond to the CDP questionnaire (*CDP*); in column (2) we regress Q on firms' decision to respond to provide information related to climate risks (*CR*); in column (3) we regress Q on firms' decisions to provide quantitative estimates related to the financial impacts of climate risks (*FI*). Robust standard errors are reported in parentheses. Institutional ownership (*InstOwn*) is truncated at 100 and all other continuous variables are winsorized at the 1% and 99% levels. All variables are defined in detail in Appendix B.

| VARIABLES | (1)<br>Q | (2)<br>Q | (3)<br>Q |
|---|---|---|---|
| logSales | -0.173*** | -0.168*** | -0.165*** |
| | (0.0151) | (0.0147) | (0.0156) |
| ROA | 0.0551** | 0.0552** | 0.0552** |
| | (0.00561) | (0.00560) | (0.00560) |
| LEV | 0.450* | 0.449* | 0.450* |
| | (0.123) | (0.123) | (0.123) |
| IntangStock | 1.485*** | 1.490*** | 1.488*** |
| | (0.131) | (0.130) | (0.130) |
| CapEx | 0.578 | 0.582 | 0.588 |
| | (0.413) | (0.416) | (0.416) |
| SalesGrowth | 0.0101** | 0.0101** | 0.0100** |
| | (0.00230) | (0.00228) | (0.00228) |
| Cash/Assets | 3.366** | 3.366** | 3.363** |
| | (0.390) | (0.388) | (0.388) |
| CDP | 0.122** | | |
| | (0.0283) | | |
| CR | | 0.0823 | |
| | | (0.0380) | |
| FI | | | 0.0693 |
| | | | (0.0457) |
| Industry controls | yes | yes | yes |
| Region controls | yes | yes | yes |
| Constant | 2.717*** | 2.689*** | 2.681*** |
| | (0.183) | (0.179) | (0.184) |
| Observations | 11,212 | 11,212 | 11,212 |
| R-squared | 0.369 | 0.368 | 0.368 |

Robust standard errors in parentheses. Standard errors clustered by firm and year.
*** p<0.01, ** p<0.05, * p<0.1

**Table 5.11: Value Relevance of Physical and Transition Risks**

Table 5.11 presents the results from regressing Tobin's Q on the number of the number of physical risks and transition risks disclosed by the firm, respectively. Panel A presents the results using the the sample of firms for which CR=1 (i.e., firms that either disclose transition risks, physical risks, or both). In column (1) both the inverse mills ration and the industry and region fixed effects are omitted; column (2) incrementally includes the industry and region fixed effects; and column (3) additionally includes the inverse Mills' ratio from the first stage regression modeling the firms' decisions to disclose climate risks (*IMR_CR*). Panel B presents the results from the same regression after including the indicator *Attest*, as well as the interaction of *Attest* with each of *TransnRisk* and *PhysRisk*. Robust standard errors are reported in parentheses and all continuous variables are winsorized at the 1% and 99% levels. All variables are defined in detail in Appendix B.

## Panel A: Firm-Value Effect of Number of Disclosed Risks

| VARIABLES | (1)<br>Q | (2)<br>Q | (3)<br>Q |
|---|---|---|---|
| logSales | -0.0455 | -0.0777* | -0.108** |
| | (0.0225) | (0.0191) | (0.0170) |
| ROA | 0.111*** | 0.102*** | 0.102*** |
| | (0.0106) | (0.00916) | (0.00923) |
| LEV | 1.479** | 0.987** | 0.970** |
| | (0.199) | (0.196) | (0.191) |
| IntangStock | 1.637** | 1.158** | 1.162** |
| | (0.198) | (0.216) | (0.216) |
| CapEx | -0.186 | 0.357 | 0.259 |
| | (0.941) | (1.009) | (1.039) |
| SalesGrowth | 0.00143 | 0.00149 | 0.00158 |
| | (0.00131) | (0.00189) | (0.00194) |
| Cash/Assets | 1.607 | 1.640 | 1.637 |
| | (0.614) | (0.659) | (0.668) |
| PhysRisk | 0.0425 | 0.0273 | 0.0271 |
| | (0.0186) | (0.0181) | (0.0179) |
| TransnRisk | -0.0475** | -0.0377* | -0.0383* |
| | (0.0103) | (0.00964) | (0.00948) |
| IMR_CR | | | -0.123 |
| | | | (0.0562) |
| Industry controls | no | yes | yes |
| Region controls | no | yes | yes |
| Constant | 0.822* | 1.554** | 1.957*** |
| | (0.232) | (0.207) | (0.191) |
| Observations | 3,512 | 3,512 | 3,512 |
| R-squared | 0.414 | 0.461 | 0.462 |

Robust standard errors in parentheses. Standard errors clustered by firm and year.
*** p<0.01, ** p<0.05, * p<0.1

## TABLE 5.11: Value Relevance of Physical and Transition Risks

### Panel B: Assurance Effect on Information Content of Disclosed Risks

| VARIABLES | (1)<br>Q | (2)<br>Q | (3)<br>Q |
|---|---|---|---|
| logSales | -0.0386 | -0.0722* | -0.105** |
| | (0.0230) | (0.0201) | (0.0175) |
| ROA | 0.111*** | 0.102*** | 0.102*** |
| | (0.0105) | (0.00915) | (0.00921) |
| LEV | 1.477** | 0.992** | 0.975** |
| | (0.198) | (0.198) | (0.193) |
| IntangStock | 1.633** | 1.164** | 1.170** |
| | (0.196) | (0.217) | (0.217) |
| CapEx | -0.241 | 0.359 | 0.249 |
| | (0.940) | (1.005) | (1.036) |
| SalesGrowth | 0.00146 | 0.00150 | 0.00160 |
| | (0.00128) | (0.00184) | (0.00188) |
| Cash/Assets | 1.589 | 1.635 | 1.632 |
| | (0.614) | (0.659) | (0.669) |
| PhysRisk | 0.0528 | 0.0372 | 0.0385 |
| | (0.0204) | (0.0202) | (0.0201) |
| TransnRisk | -0.0496* | -0.0436* | -0.0451* |
| | (0.0127) | (0.0126) | (0.0124) |
| Attest | -0.111 | -0.0577 | -0.0692 |
| | (0.0547) | (0.0506) | (0.0520) |
| Attest x PhysRisk | -0.0157 | -0.0187 | -0.0215 |
| | (0.0298) | (0.0264) | (0.0266) |
| Attest x TransnRisk | 0.0105 | 0.0150 | 0.0174 |
| | (0.0172) | (0.0162) | (0.0164) |
| IMR_CR | | | -0.138 |
| | | | (0.0587) |
| Industry controls | no | yes | yes |
| Region controls | no | yes | yes |
| Constant | 0.805* | 1.512** | 1.955*** |
| | (0.233) | (0.218) | (0.196) |
| Observations | 3,512 | 3,512 | 3,512 |
| R-squared | 0.416 | 0.462 | 0.463 |

Robust standard errors in parentheses. Standard errors clustered by firm and year.
*** p<0.01, ** p<0.05, * p<0.1

### Table 5.12: Year-by-Year Value Relevance of Physical and Transition Risks

Table 5.12 presents the year-by-year results from regressing Tobin's Q on the number of the number of physical risks and transition risks disclosed by the firm, respectively, using the the sample of firms for which CR=1 (i.e., firms that either disclose transition risks, physical risks, or both). The results for 2018 are presented in column (1), the results for 2019, in column (2), and the results for 2020 in column (3). Standard errors are reported in parentheses and all continuous variables are winsorized at the 1% and 99% levels. All variables are defined in detail in Appendix B.

| VARIABLES | (1)<br>Q 2018 | (2)<br>Q 2019 | (3)<br>Q 2020 |
|---|---|---|---|
| logSales | -0.0759*** | -0.115*** | -0.116*** |
| | (0.0280) | (0.0296) | (0.0349) |
| ROA | 0.0914*** | 0.106*** | 0.113*** |
| | (0.00453) | (0.00479) | (0.00531) |
| LEV | 1.141*** | 1.012*** | 0.684*** |
| | (0.192) | (0.206) | (0.222) |
| IntangStock | 1.361*** | 1.303*** | 0.938*** |
| | (0.165) | (0.184) | (0.211) |
| CapEx | -1.260* | -0.255 | 2.066** |
| | (0.721) | (0.724) | (0.860) |
| SalesGrowth | 0.00321 | -0.000203 | -0.00123 |
| | (0.00228) | (0.00284) | (0.00258) |
| Cash/Assets | 0.893*** | 1.289*** | 2.780*** |
| | (0.273) | (0.332) | (0.366) |
| PhysRisk | 0.0523** | 0.0156 | 0.0146 |
| | (0.0226) | (0.0263) | (0.0301) |
| TransnRisk | -0.0342** | -0.0313* | -0.0398** |
| | (0.0141) | (0.0174) | (0.0202) |
| IMR_CR_2018 | -0.154** | | |
| | (0.0782) | | |
| IMR_CR_2019 | | -0.159* | |
| | | (0.0892) | |
| IMR_CR_2020 | | | -0.106 |
| | | | (0.113) |
| Industry controls | yes | yes | yes |
| Region controls | yes | yes | yes |
| Constant | 1.686*** | 2.029*** | 2.031*** |
| | (0.368) | (0.398) | (0.455) |
| Observations | 1,034 | 1,173 | 1,305 |
| R-squared | 0.520 | 0.496 | 0.463 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

### Table 5.13: Value Relevance of Financial Impacts of Climate Risks

Table 5.13 presents the results from regressing Tobin's Q on the estimates of the financial impacts of climate risks, using all available firm-years for which the *FinImpact* disclosure was provided and was not deemed to be erroneous or suspect. In column (1) both the inverse mills ration and the industry and region fixed effects are omitted; column (2) incrementally includes the industry and region fixed effects; and column (3) additionally includes the inverse Mills' ratio from the first stage regression modeling the firms' decisions to disclose financial impacts information (*IMR_FI*). Robust standard errors are reported in parentheses and all continuous variables are winsorized at the 1% and 99% levels. All variables are defined in detail in Appendix B.

| VARIABLES | (1)<br>Q | (2)<br>Q | (3)<br>Q |
|---|---|---|---|
| logSales | -0.0292 | -0.0533* | -0.0798* |
| | (0.0205) | (0.0146) | (0.0242) |
| ROA | 0.108*** | 0.0998*** | 0.0995*** |
| | (0.00814) | (0.00722) | (0.00734) |
| LEV | 1.069 | 0.612 | 0.608 |
| | (0.388) | (0.356) | (0.351) |
| IntangStock | 1.438** | 1.123** | 1.119** |
| | (0.290) | (0.252) | (0.250) |
| CapEx | 0.662 | 1.677 | 1.586 |
| | (0.906) | (0.862) | (0.892) |
| SalesGrowth | 0.00125 | 0.00154 | 0.00171 |
| | (0.00188) | (0.00196) | (0.00205) |
| Cash/Assets | 1.404 | 1.621 | 1.611 |
| | (0.647) | (0.704) | (0.717) |
| FinImpact | -0.422* | -0.179 | -0.183 |
| | (0.124) | (0.137) | (0.140) |
| IMR_FI | | | -0.105 |
| | | | (0.0943) |
| Industry controls | no | yes | yes |
| Region controls | no | yes | yes |
| Constant | 0.759 | 1.189** | 1.567** |
| | (0.278) | (0.168) | (0.337) |
| Observations | 2,038 | 2,038 | 2,038 |
| R-squared | 0.422 | 0.472 | 0.472 |

Robust standard errors in parentheses. Standard errors clustered by firm and year.
*** p<0.01, ** p<0.05, * p<0.1

# 6 Conclusion

This thesis set out to gain a better understanding of corporate action on climate change by examining how companies act in response to intensifying decarbonisation and ongoing commercial imperatives. The issue of corporate action on climate change is all the more important as global carbon emissions have continued to rise largely unabated over the last decade[63] (Peters et al., 2020), setting the world on track to reach 1.5 degrees of warming compared to pre-industrial levels in the early 2030s. To mitigate (further) climate change and reduce the likelihood of negative climate impacts, global anthropogenic carbon emissions need to reach net zero around 2050 (IPCC, 2018). This requires a transition from an economy built around climate-forcing assets that accelerate climate change to an economy centred on climate-saving assets that enable an economic system with net zero emissions (Colgan et al., 2021; Paterson, 2021).

As key actors holding and controlling climate-forcing and climate-saving assets, companies are at the very heart of this transition and can function either as obstacles or enablers of climate change mitigation. It is thus important to gain a better understanding of the ways in which companies navigate the transition to a low-carbon economy and act (or not) on climate change. Drawing on economic geography, organisation and management, and accounting research, this thesis examines corporate action on climate change through three complementary perspectives on time, risk, and value. In this concluding chapter, I revisit the key findings of the thesis (see Table 6.1 below) and outline implications for both research and practice. After summarising how each of the three substantive core chapters sheds light on corporate action on climate change, I reflect on the limitations of the thesis and highlight avenues for further research.

[63] Carbon emissions in 2020 were 7% lower than in 2019 as a result of the measures introduced against the Covid-19 pandemic (Le Quéré et al., 2021). However, emissions bounced back rapidly in 2021 and all but erased the emission reductions during the pandemic (Tollefson, 2021).

**Table 6.1: Overview of Chapter Findings**

| | Chapter 3 | Chapter 4 | Chapter 5 |
|---|---|---|---|
| Perspective | Time | Risk | Value |
| Title | It's About Time? The Role of Temporal Orientation in Corporate Climate Change Mitigation | Climate Risk as Linguistic Cleansing: Strategic Responses to the Climate Crisis by Carbon-Intensive Corporations | TCFD Climate Risk Disclosures: Early Evidence on the "Gold Standard" |
| Objective | Examine relationship between organisational time orientation and corporate carbon emissions. | Explore how companies reconcile institutional demands to reduce carbon emissions (climate-stewardship logic) with pressure to create shareholder value (market logic). | Examine determinants and capital market implications of corporate climate risk disclosure. |
| Key Finding | Long-term oriented companies invest more in decarbonisations measures and have lower carbon emissions. | Companies reconcile market and climate-stewardship logics by transforming system-level problem of climate change into managerial – and thus manageable – object of climate risk. | Except for transition risks – where the number of disclosed risks is negatively associated with share prices – self-reported climate risk exposures are not reflected in stock market values |

## 6.1 Findings and Contributions

### 6.1.1 Chapter 3

Chapter 3 builds on work emphasising the importance of time in corporate action on climate change (Sarasini & Jacob, 2014; Slawinski et al., 2017; Slawinski & Bansal, 2012, 2015) and examines the relationship between organisational time orientation and corporate carbon emissions. The predictor variable organisational time orientation is operationalised as a multi-dimensional construct that is measured on three levels, including (1) temporal focus of CEOs, (2) time orientation of executive compensation (forward-looking targets; sustainability factors), and (3) time orientation of ownership structure (share of long-term oriented shareholders). The chapter finds that the long-term orientation of CEOs is negatively associated with corporate carbon emissions, suggesting that companies led by long-term oriented CEOs invest more in decarbonisation measures and emit less carbon. This is consistent with findings that investor-owned utility companies led by

CEOs with longer time perspectives are more likely to commit to long-term investments in environmentally responsible technologies, resulting in a higher share of electricity generated from renewable sources (Ortiz-de-Mandojana et al., 2019).

Unexpectedly, however, the integration of forward-looking targets into executive remuneration packages is not significantly associated with carbon emissions, whereas the inclusion of sustainability incentives in executive compensation is positively – rather than negatively – related to carbon emissions. This suggests that companies in which executives' compensation is at least partially determined by sustainability criteria tend to undertake less effective climate action and thus have higher carbon emissions. A possible explanation is that the scope or type of sustainability criteria included in executive compensation packages is insufficient for directing managerial attention to long-term sustainability outcomes (Maas, 2018). In this case, the use of sustainability-linked incentives may be symbolic – rather than substantive – to deflect stakeholder demands for climate action through the implementation of superficial – but ineffective – governance arrangements (Berrone & Gomez-Mejia, 2009; Bowen, 2014). Finally, the chapter finds that the long-term orientation of shareholders is negatively associated with corporate carbon emissions, indicating that companies with a higher share of long-term oriented shareholders invest more in decarbonising their businesses and have lower GHG emissions.

Employing an innovative multi-level approach to measuring organisational long-term orientation – combining established compensation- and shareholder-related measures with a psycholinguist measure – the chapter is one of the first studies to empirically test the relationship between organisational time orientation and corporate carbon emissions (Slawinski et al., 2017). The findings make several contributions to the organisation, management, and strategy literature. First, the chapter provides empirical support for the proposition that long-term oriented companies have lower corporate carbon emissions

(Slawinski et al., 2017). This finding complements case study research showing that temporal perspectives shape corporate action on climate change (Sarasini & Jacob, 2014; Slawinski & Bansal, 2012, 2015).

Second, the chapter responds to calls for organisation and management research that is more attentive to the physical materiality of the natural environment (Bansal & Knox-Hayes, 2013; Whiteman et al., 2013; Winn & Pogutz, 2013). By focusing on the biophysical impacts of companies on climate change – measured as corporate carbon emissions – the chapter contributes to the curiously small number of studies that empirically examine how organisational features shape the relationship between companies and the natural environment. The findings add to prior research showing that certain organisational processes, such as more ambitious emission target setting, are associated with lower carbon emissions (Dahlmann et al., 2017; Ioannou et al., 2016).

Third, the chapter contributes to the growing organisation and management literature exploring temporal aspects of strategic management. Prior empirical research has largely focused on North American settings, but perceptions and experiences of time are culturally situated (Bluedorn, 2002), limiting the generalisability of extant research to other geographies. This chapter addresses this gap by contributing insights into the time-climate change nexus from a European setting. Finally, this chapter illustrates the possibility of conducting empirical research at the interface of organisation studies and economic geography. While grounded in organisation and strategic management research, the study is informed by the analytical focus of economic geography on temporal and spatial aspects of economic processes to empirically examine corporate action on climate change (Bansal & Knox-Hayes, 2013).

### 6.1.2 Chapter 4

Chapter 4 explores corporate action on climate change from a risk perspective and examines the question how carbon-intensive companies reconcile growing institutional demands to reduce emissions (a climate-stewardship logic) with the constant pressure to create shareholder value (a market logic). The chapter identifies four distinct types of strategic responses to the climate crisis that are enacted by carbon-intensive companies in Europe: Green Transition, Green Segmentation, Engagement, and Defensive Strategies. Each of these strategies was associated with and shaped by distinct conditions and calculative practices that yielded different approaches to reconciling the market and climate-stewardship logics, which included both the explicit (Green Transition) and partial (Green Segmentation) alignment of business models with the climate-stewardship logic as well as attempts to seek external support to satisfy decarbonisation demands (Engagement) and the deliberate deflection of decarbonisation pressures (Defensive). The perceived tension between climate stewardship and the market logic was particularly acute for companies holding predominantly climate-forcing assets associated with substantial carbon emissions. In contrast, companies in control of climate-saving assets that either facilitated carbon emission reductions or were less carbon-emission intensive experienced less tensions between the plural demands for climate stewardship and profits. The perceived tension between the climate-stewardship and market logic was also shaped by calculative practices that were implicated in reformatting the climate crisis as a risk entailing threats and opportunities. Accounting thus both reflected and contributed to the varied strategic responses by rendering the costs, threats, and opportunities associated with the climate crisis visible and actionable.

The key insight of Chapter 4 is that companies reconcile climate-stewardship and market logics through reformatting climate change as climate risk, which transforms the seemingly intractable system-level problem of climate change into an issue manageable by companies. The managerialisation of the climate crisis is facilitated by calculative practices that construct climate risk as a new management object. This construction goes hand in hand with a performative act of *linguistic cleansing* (Barnhizer, 2013), a language control strategy deployed by adherents of the market logic that reshapes the moral, management, and ideological imperatives surrounding corporate action on climate change. Reformatting the abstract, system-level challenge of climate change into organisation-level climate risks compels even companies holding primarily climate-forcing assets to register the *moral imperative* to act on climate change – either by pursing strategies that accommodate or compromise with the climate-stewardship logic.

In terms of *managerial imperatives,* the chapter accords with previous research that identifies two organisational responses to institutional complexity, which either seek to keep conflicting institutional demands separate (structural segmentation) or aim to integrate competing institutional logics (blending) (Dunn & Jones, 2010; Glynn & Lounsbury, 2005; Greenwood et al., 2011; Pache & Santos, 2010; Pache & Santos, 2013). Structural segmentation was reflected in companies enacting Green Segmentation and Engagement Strategies, whereas blending was apparent in companies pursuing Green Transition Strategies.

Finally, the managerialisation of climate change touches on the *ideological imperatives* underpinning the modes of governance over the climate crisis. The construction of climate risk as a new management object shifts the underlying logic of appropriate governance from a predominantly state-driven response to climate change (i.e. climate stewardship by regulating corporate actors) to a primarily market-driven response enacted by corporate actors with various degrees of dependence on governmental support (i.e. market logic enacted by largely self-regulating corporate actors). In this market-based governance approach, companies act on climate change insofar as it protects or strengthens their profitability by mitigating threats or seizing opportunities as envisioned by the newly constructed management object climate risk. In other words, corporate action on climate change is predicated on the moral and ideological right of corporations to earn profits.

Much hinges then on the definition of profits and to what extent the costs of climate change are accounted for in profit calculations. Carbon markets and other mechanisms designed to put a price on carbon emissions can thus be understood as attempts at incorporating climate-related costs into the profit calculus of companies. Importantly, market-based governance approaches should not be mistaken as being completely devoid of government action. Quite the contrary, this chapter has shown that many companies perceive national and supranational policies as important climate-related threats and, in particular in the case of Engagement Strategies, companies turn to policymakers and other stakeholders for support in addressing those threats through the decarbonisation of business models. Corporate action is thus also political action on climate change and the notion of climate risk, with its emerging calculative infrastructure, may entrench existing ways of doing or forge new cross-sectoral alliances that make or break the transition to a low-carbon economy.

The chapter responds to calls for research into the role of risk management in corporate action on climate change (O'Dwyer & Unerman, 2020) and the findings make two distinct contributions to extant literature in organisation and accounting studies. First, the chapter extends prior research examining how organisations organizations reconcile pluralistic institutional demands or logics (e.g. Greenwood et al., 2011; Oliver, 1991; Pache & Santos, 2010; 2013). Whereas prior studies have emphasised leadership and hiring practices as antecedents of organisational responses to institutional complexity (Battilana

& Dorado, 2010; Pache & Santos, 2013), this chapter sheds light on the role of technological endowments (climate-savings and climate-forcing assets) and calculative practices in reconciling climate stewardship and market logics. Second, the chapter adds to sociological perspectives in accounting research on the "quantifying, economising and marketising" of public and organizational life (Kurunmäki et al., 2016; Miller & Power, 2013) by showing how calculative practices are implicated in reformatting a system-level problem (climate change) into a managerial—and seemingly manageable—object (climate risk).

### 6.1.3 Chapter 5

Having provided insights into the role of calculative practices in constructing climate risk as a new management object – and the implications for corporate action on climate change – the thesis shifts focus from internal processes (managerial accounting) to the production of and capital market reactions to corporate disclosures of climate risk (financial accounting). This shift in focus was motivated by insights from the research interviews underpinning Chapter 4, in which interview partners frequently identified investors as important drivers that had pushed climate risks higher up on corporate agendas, but questions were raised to what extent capital markets had integrated companies' climate risk exposure into firm valuations. Chapter 5 thus examines the determinants of companies' decision to provide voluntary climate risk disclosures and the extent to which these disclosures are reflected in the stock market value values of publicly listed companies. In the first set of analyses, the chapter finds that firm size, institutional ownership, indicators of the firm's commitment to sustainability, industry membership, and geographical region are significant determinants of voluntary climate risk disclosure. Supplementary analyses show, for the subset of firms for which this data is available, that corporate environmental performance is also an important determinant of climate risk disclosure, whereas the role of carbon emission depends on how emissions are measured. These findings are largely consistent with prior research in the context of voluntary sustainability disclosures (Clarkson et al., 2008; Liesen et al., 2015; Matsumura et al., 2014).

In a second set of analyses, the chapter finds that companies' decision to disclose climate risks is not significantly associated with stock market values, suggesting that there is little signalling value to providing voluntary climate risk disclosures. Examining whether the number of disclosed physical and transition climate risks are reflected in a company's stock market value, the chapter also documents that the number of disclosed transition risks is negatively associated with firm value. This is consistent with capital markets treating risks associated with the transition to a low-carbon economy – such as the financial impacts of carbon taxes or climate-related litigation – as a legitimate threat to the firm's business model and future prospects. However, neither the number of disclosed physical risks nor the estimated financial impacts of climate risks are significantly associated with firm value. This finding is somewhat surprising considering the high levels of support that voluntary climate risk disclosures have received from influential capital market players and regulators. Indeed, survey evidence indicates that investors consider climate risks as important investment risks (Krueger et al., 2020) and, consequently, seek material climate-risk-related financial information (Herren Lee, 2020). Yet this chapter finds limited evidence that corporate climate risk disclosures – sourced from the only authoritative body (CDP) that directly gathers company-provided climate risk information in a standardised format – are significantly associated with share prices. Possible explanations are that (1) investors do not consider climate risk disclosures (except number of disclosed transition risks) as credible, material, imminent threats to firm prospects, (2) investors don't understand or fully process the disclosed information, or (3) investors simply do not pay attention to these climate risk disclosures.

The possibility that investors are inattentive or dismiss the credibility of the disclosures needs to be taken seriously in light of the data quality issues encountered while working with the raw data that underpins the research in this chapter. A manual inspection of the data purchased from CDP – an organisation that prides itself to be the "gold standard of environmental reporting" (CDP, 2022) – revealed that the database is riddled with errors and irregularities when it comes to financial impact estimates of climate risk. While the analyses underpinning the reported findings were corrected for these inaccuracies, investors might well conclude that this data is not robust enough to be included in investment processes and decisions. Determining how investors perceive the quality of climate risk disclosures is beyond the scope of the chapter, but it offers a valuable avenue for further research.

The chapter's findings have several implications for corporate action on climate change and market-based governance approaches to the climate crisis. First, the large sample evidence confirms doubts expressed by interview participants in Chapter 4 that investors do not systematically incorporate companies' self-reported climate risk exposures into firm valuations. With the exception of transition risks – where the number of disclosed risks is negatively associated with share prices – self-reported climate risk exposures are not reflected in stock market values. Although companies might receive pressure from individual investors to act on climate risks, the findings suggest that this pressure does not translate into firm valuations and thus indicates that investors in aggregate do not consider climate risks disclosed by companies to be value relevant. This is consistent with claims from practitioners and regulators that climate risks are not fully priced in capital markets (Arnold, 2020; CFTC, 2020; International Monetary Fund, 2020a; Schnabel, 2020). For publicly listed companies, this suggests that self-disclosed climate risk exposure is currently neither penalised nor rewarded by capital markets. The exception is the number of disclosed transition risks, which is negatively associated with firm value, indicating that investors deem carbon pricing, climate-related litigation, and other risks associated with the transition to a low-carbon economy as a legitimate threat to companies' profitability. This is consistent with the findings of Chapter 4 showing that companies seek to mitigate these risks by enacting different climate response strategies conditioned by distinct asset portfolios and calculative practices.

Second, the findings suggest that climate risk disclosure in its current shape and form is not living up to the central promises of market-based governance approaches that emphasise enhanced transparency through disclosures as the key instrument to prevent mispricing of climate risks in capital markets, facilitate more efficient capital allocation, and enable a smooth transition to a low-carbon economy (Carney, 2015; TCFD, 2017b). This empirical finding aligns with critiques that draw parallels with the failure of market-based governance structures in the 2008-9 financial crisis and question the efficacy of disclosure-based governance regimes in protecting financial stability in a rapidly warming world (Christophers, 2017). The glaring data quality problems uncovered in this chapter suggest that the technocratic climate-risk-disclosure-as-governance approach may be hampered, somewhat ironically, by fundamental *technical* deficiencies and a non-governmental organisation (CDP) seemingly unwilling to take remedial action. This echoes prior work on disclosure-based governance documenting the challenges of NGOs such as CDP in providing consistent, comparable, and decision-useful carbon emission data to investors and other stakeholders (Knox-Hayes & Levy, 2011). With corporate climate risk disclosures poised to become mandatory in numerous jurisdictions, this chapter is the first study to provide large sample evidence related to the determinants and capital market implications of climate risk disclosures that should be informative to policy makers and regulators, as well as to investors who are apparently ignoring potentially materially information.

The findings contribute to voluntary disclosure and capital market research in the financial accounting field. While there is an extensive literature on corporate climate change disclosures, prior research has primarily focused on examining the determinants and consequences of carbon emissions disclosures (e.g. Hahn et al., 2015). Much of this literature examines the association of firm value with a measure of a firm's impact on climate change (i.e. carbon emissions), which is at best an indirect and incomplete proxy of corporate climate risk exposure since it captures primarily the exposure of companies to policy-related risks (e.g. carbon pricing schemes). Exploiting a novel dataset of standardised climate risk disclosure in accordance with the TCFD framework, this chapter is one of the first studies to provide empirical insights into the determinants and capital market implications of more holistic climate risk disclosures.

### 6.1.4 Thesis

The key contribution of this thesis is to shed light on the role of companies in driving, mitigating, and adapting to climate change. Prior research in economic geography has provided valuable perspectives on the evolution and functioning of the carbon economy, a phenomenon produced by market-based governance approaches to controlling and reducing carbon emissions. However, companies as key actors in the carbon economy have received surprisingly little attention by economic geographers. By adopting a decidedly organisational perspective and examining corporate action on climate change, this thesis provides novel insights into the inner workings, strategies, and impacts of companies in the carbon economy.

Moreover, the insights gained from studying corporate action on climate change offer new perspectives on the carbon economy itself. The lacuna of firms in prior research may reflect the early stage of market-based governance approaches in the 2000s and early 2010s. In Europe, for example, the emission trading scheme was launched in 2005 and the market for emission allowances was long characterised by relatively low prices – reaching an all-time low of less than €5 in 2013 – and generous free allocations of emission allowances for certain heavy industry sectors. These carbon market conditions may have been simply insufficient to jolt companies into any meaningful action, possibly explaining the lack of research on corporate action in the carbon economy. However, the carbon price in the European Union increased more than tenfold from €8 in early 2018 to €90 in December 2021. This thesis documents how this increased carbon price and a host of other developments – including ambitious policies, changing customer demands, civil society movements, and investor engagement on climate change – have triggered heavy industry companies in the European Union into action. Based on research on some of Europe's largest corporate carbon emitters, the thesis proposes that the carbon economy – at least in Europe – has entered a new paradigm where inaction on climate change is simply no longer an option for companies. In this new paradigm – a carbon economy 2.0 – the imperative to reduce carbon emissions is beginning to percolate through value chains and poses strategic challenges for companies that go well beyond building the technocratic capabilities to comply with regulatory mechanisms such as carbon markets (Engels, 2009). This thesis provides evidence on the contours of this emerging carbon economy 2.0 through the eyes of its central actors – companies in carbon-intensive industries.

At the core of this thesis' contribution are a set of novel insights into how companies navigate and shape the emerging carbon economy 2.0. Structured by the three analytical themes of time, risk, and value, the findings of this thesis show that organisational processes give rise to distinct corporate actions on climate change, which in turn produce differentiated socioeconomic and biophysical outcomes. First, on *time*, the thesis finds that organisational time orientation is associated with corporate carbon emissions, raising the possibility that long-term oriented companies are less prone to compress time and thus more likely to bridge the temporal features of the social and the natural world when tackling the intertemporal choice problem of decarbonising the business (Bansal & Knox-Hayes, 2013).

Second, on *risk*, the thesis shows that calculative practices enable the managerialisation of the climate crisis by constructing climate risk as a novel management object that can be dealt with by four types of corporate strategies. The insights into importance of calculative practices in mediating corporate action on climate change extends prior work in economic geography on the significance of calculative infrastructures for the operation of carbon markets (e.g. Lovell & MacKenzie, 2011). Furthermore, this thesis adds to geographic research on riskscapes (Müller-Mahn et al., 2018; Müller-Mahn & Everts, 2013), which has recently been leveraged to advance the understanding of climate change dynamics (Davies, Hooks, Knox-Hayes, & Liévanos, 2020; Everts & Müller, 2020). Riskscapes are socially produced "collective imaginations of complex, multiple and overlapping risk settings" that – analogous to maps – locate threats in time and space and provide "orientation in potentially perilous terrain" (Müller-Mahn et al., 2018, p. 197). This thesis provides empirical insights into the ways in which companies construct and navigate climate riskscapes, demonstrating how the construction of these riskscapes enables and shapes variegated corporate action on climate change.

Finally, on *value*, the thesis demonstrates that corporate climate risk disclosures are by and large not reflected in companies' stock market values, indicating that companies are neither rewarded nor punished by capital markets for their self-reported exposure to climate risks. This finding adds to prior work on disclosure-based governance approaches to climate change in economic geography (Knox-Hayes & Levy, 2011; Pattberg, 2012) and provides early evidence in line with critical perspectives questioning the efficacy of climate risk disclosures in protecting financial stability in the wake of a rapidly changing climate (Christophers, 2017).

Overall, this thesis sheds light on a surprising blind spot of climate change-related research in economic geography and that is the role of companies in an evolving carbon economy. As such, this thesis is an extension of existing research into market-based governance approaches to climate change that provides novel insights into the ways in which the carbon economy is practiced and shaped by its corporate key actors. The findings have several implications for economic geography research on the carbon economy. First, the carbon economy in Europe has entered a new paradigm that is characterised by significantly higher pressures on companies to transition from carbon-forcing to carbon-saving assets. These pressures are as much commercial as political, with companies in carbon-intensive industries (e.g. steel manufacturing) facing existential risks from a combination of high domestic carbon prices and intense competition on global markets. There are early signs that these pressures are selectively triggering transitional processes towards a low-carbon economy. A case in point is the application of hydrogen in various industrial processes, which may result in fundamental changes to industrial structures and value chains. Just as the emergence of carbon markets allowed economic geographers to study the evolution and construction of a novel market in real time (Knox-Hayes, 2016), so does the emerging carbon economy 2.0 provide ample opportunities to examine *in vivo* many phenomena of great interest to economic geographers, such as the emergence (and potential demise) of industrial clusters and production networks.

Second, companies are at the very centre of the carbon economy and their actions are consequential for the shape of the carbon economy and, more importantly, for societal efforts to mitigate climate change. Examining corporate action on climate change thus offers a productive way of researching the next iteration of the carbon economy. To date, the story of economic geography research on the role of companies in the carbon economy is one of unfulfilled potential. This thesis is a first attempt at realising this potential, but more efforts are needed to flesh out – both conceptually and empirically – the antecedents, processes, and consequences of corporate activities in the carbon economy. The global production network (GPN) framework could be a useful platform for furthering this research agenda. The GPN framework with its analytical focus on the complex networks of firm and non-firm actors involved in the global production, distribution, and consumption of products and services is well-suited to researching the evolving carbon economy (Coe & Yeung, 2019). Companies are central to the GPN framework as constitutive elements of production networks and recent iterations of the GPN framework further highlight the agency of firms by identifying a set of actor-specific strategies to explain the emergence and configuration of GPN (Coe & Yeung, 2015). Importantly, the adoption of these strategies is explained by the exposure of companies to a particular set of competitive dynamics and risk environments (Yeung & Coe, 2015). This introduction of risk exposure as a causal driver of firm strategies shaping the emergence and configuration of production networks offers a promising avenue to leverage the insights of this thesis into corporate response strategies to climate risk and advance the conceptualisation of corporate action in the carbon economy using the GPN framework.

## 6.2 Further Research

This section will reflect on the main limitations of the thesis and point out numerous avenues for further research at the interface between economic geography, organisation and management, and accounting.

*Broadening geographical scope*

First and foremost, the empirical work presented in this thesis is largely focused on Europe, with Chapter 3 and Chapter 4 examining companies in carbon-intensive industries with headquarters in the European Union and Chapter 5 broadening the industrial and geographical scope to companies from advanced economies. The European focus in Chapter 3 and Chapter 4 was a deliberate research design choice motivated by the presence of ambitious policies, vocal civil society movements (e.g. Fridays for Future), advanced consumer awareness, and active investor engagement around climate change. As a result, companies in Europe are exposed to substantial pressures to act on climate change, making Europe a particularly useful research context for the purpose of this thesis. Yet the features that designate Europe as the empirical context of choice limit the generalisability of the findings to other geographies. For example, perceptions and experiences of time differ across cultural settings (Bluedorn, 2002) and the relationship between organisational time orientation and corporate climate action might manifest differently in different parts of the world. Likewise, notions of risk are culturally, and thus geographically, differentiated (Douglas & Wildavsky, 1982; Müller-Mahn & Everts, 2013) and the construction of climate risk as a distinct management object might play out differently in different geographies (Davies et al., 2020). Extending the studies on time and risk presented in this thesis to other geographical contexts would thus be a valuable avenue for further, possibly comparative, research.

*Navigating the transition to low-carbon economy*

This thesis explores how companies grapple with reconciling growing institutional demands to reduce carbon emissions (a climate-stewardship logic) with the constant pressure to create shareholder value (a market logic). As companies seek to accommodate the climate-stewardship logic and reduce carbon emissions, new technologies, alliances, and dependencies emerge that alter longstanding economic and industrial structures. The efforts to decarbonise the steel industry illustrate this point, but it applies to other types of heavy industrial processes as well. Whereas conventional steel manufacturing relies on coal – a cheap commodity widely available on global markets – as a key production input, the decarbonisation of steel manufacturing requires vast amounts of renewable energy – a production input that typically needs to be sourced in proximity to the manufacturing site and presents new challenges in terms of dependencies, costs and availability. In response to these challenges, steel and other heavy industry companies, together with utilities, have begun forming alliances to develop new industrial clusters that foster and scale low-carbon production processes. This is just one example of how transitioning to a low-carbon economy shapes up to alter global production networks and these unfolding developments offer ample research opportunities for economic geographers and organization and management scholars alike. More research is needed to understand the emerging alliances, strategies, and practices of companies – and their socioeconomic and spatial effects – as they seek to navigate the low-carbon transition.

*Adapting to a rapidly changing climate*

The thesis has examined corporate action on climate change primarily under the aspect of mitigation rather than adaptation. This is partly a function of the inherent time and resource constraints of a DPhil project, but it also reflects the empirical material collected for this thesis. Physical climate impacts played a minor role in interviews with companies and interview participants were primarily concerned with societal efforts to mitigate climate change. However, there were some signs that companies are beginning to register climate change as an adaptation challenge. For example, several interview partners reported that company sites in Germany experienced severe supply chain disruptions due to low water levels in the river Rhine following persistent drought-like conditions in 2018. As the consequences of a rapidly changing climate become ever more apparent, studying the climate impacts on economic and corporate activities presents an important and prolific research avenue. Economic geographers in particular are well positioned to research the spatially differentiated effects of climate change on economic assets, regions, sectors, and firms (Leichenko, 2018; Peri & Robert-Nicoud, 2021).

*Consequences and effectiveness of climate risk disclosures*

Chapter 4 documents how companies leverage the notion of climate risk to transform climate change into a management object that is that is addressable by corporate action. Climate risk as a concept has gained significant momentum in recent years and this ascent in public (and corporate) awareness is at least partly rooted in the work of the Task Force on Climate-Related Financial Disclosure (TCFD). With an explicit concern for protecting financial stability, the TCFD has promoted climate risk disclosure as a key instrument for preventing the mispricing of climate risk and enabling a smooth transition to a low-carbon economy. Chapter 5, however, finds that corporate climate risk disclosures are not reflected in stock market values, suggesting that this disclosure-based governance approach falls short of delivering its core promise. This calls for more research into the consequences and effectiveness of climate risk disclosures, especially as policymakers and regulators in numerous geographies contemplate making these disclosures mandatory. For example, future studies could explore how investors perceive the quality and decision-usefulness of climate risk disclosures and how these disclosures are considered in investment processes.

*Emergence of novel climate risk analytics*

In light of the quality issues of corporate disclosures uncovered in Chapter 5, further research could explore alternative approaches to assessing corporate climate risk exposure. Measuring and managing climate and environment-related risks with novel geospatial data analytics is a particular promising area for research and practice (Caldecott et al., 2018). With declining satellite launch costs and advances in artificial intelligence facilitating the analysis of large datasets, geospatial data generated by remote sensing technologies is becoming more widely available and raises the prospect of spatial finance – "the integration of geospatial data and analysis into financial theory and practice" (Spatial Finance Initiative, 2021, p. 5). This offers not only exciting research opportunities to financial geographers, but it should also be of interest to accounting researcher and practitioners, since the availability of geospatial data analytics may disrupt the reliance on self-reported corporate disclosures and adjacent activities such as assurance and audit. The possibility of "audits from space" – the analyses of corporate activities enabled by satellite imagery and other remote sensing technologies – has also implications for corporate action on climate change. For example, it opens new frontiers of accountability by creating more visibility around the impact of companies on climate change and other environmental areas of concern.

*Corporate action on climate change as a multidisciplinary object of study*

Finally, this thesis has attempted to highlight the potential of corporate action on climate change as a multidisciplinary object of study, but much remains to be done to formalise and solidify the conceptualisation of companies as socio-ecological actors whose actions shape and are shaped by climate change. The interface of the three disciplines that this thesis draws on – economic geography, accounting, and organisation and management studies – has a lot to offer to advance insights into corporate action on climate change and it is up to future research to explore and realise this potential.

## 6.3 Concluding Remarks

The fundamental premise of this thesis is that companies are central actors in our economic system whose actions are intimately connected with the success or failure of societal efforts to mitigate climate change. As economic actors in control of climate-forcing and climate-saving assets, companies are an instrumental part of transitioning to a low-carbon economy – either as obstacles trying to protect the viability of carbon-forcing assets or as enablers scaling the deployment of carbon-saving assets. From extracting and burning fossil fuels to generating renewable energy and implementing low-carbon productions processes, the actions of companies either accelerate or slow climate change and thus shape the trajectory of humanity on a rapidly warming planet. Of course, corporate action on climate change is not merely the consequence of decisions taken in corporate boardrooms, but it is conditioned by a complex web of other actors (policymakers, investors, consumers, and many others) that operate across multiple domains and scales. Navigating the low-carbon transition is thus a collaborative enterprise and requires companies to forge new alliances, orchestrate cross-sectoral partnerships, and in some cases build entirely new value chains. Hence, corporate action on climate changes is a boundary spanning phenomenon that is as much about economics as it is about politics, technology, and sciences. As a field of study, it calls for a multi-disciplinary research approach that transcends conventional boundaries of academic disciplines, methodologies, and paradigms. As a field of practice, it requires the collaboration of companies with a diverse set of actors to strike a path towards a low-carbon economy. Given the scale of the challenge, transitioning to a low-carbon economy is too big a problem to leave to companies alone, but it is also too grand a challenge to solve without their involvement.

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# 8 Appendix

## Co-Authorship Statement

The thesis comprises three empirical research papers that constitute Chapter 3, 4, and 5 in this thesis. The first paper (Chapter 3) was sole-authored; the second paper (Chapter 4) was co-authored with Dr Anette Mikes, Associate Professor of Accounting at Saïd Business School, Oxford University; and the third paper (Chapter 5) was co-authored with Dr Elizabeth Demers, Professor of Financial Accounting at University of Waterloo, Canada. I hereby confirm that I have made substantive contributions to both co-authored papers across all stages of the respective research projects, including the design and implementation of the research, the collection, analysis, and interpretation of data, and the writing of the manuscripts.