The Efficacy of Climate-Related Financial Disclosures: How do Investors Respond to Transparency?

Ira B. **Poensgen**

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Ira Beatrice Poensgen
Oxford Sustainable Finance Group, Smith School of Enterprise and the Environment
University of Oxford

Contact:
Ira Poensgen
E-mail: ira.poensgen@ouce.ox.ac.uk

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ABSTRACT

In recent years, we have witnessed a wave of policy action by financial supervisors pushing for climate-related financial disclosures. These efforts are underpinned by two core expectations, namely that investors value the transparency of firms who disclose, and that they will shift investments towards firms that exhibit a higher degree of climate risk stewardship. To date, however, little research has investigated whether these expectations hold in practice. Addressing this gap, this paper presents an empirical investigation of the influence of firm-level disclosures on the equity investment decisions of the Norwegian Sovereign Wealth Fund (NWF). Building on a novel dataset that matches the fund's 2018 and 2019 equity portfolios with disclosure scores awarded by the Carbon Disclosure Project and firm-level economic data, I investigate how the NWF reacts to firms' disclosures. My results indicate that, in the period considered, neither of the two hypotheses underlying the regulatory push for disclosures holds. Neither participation in voluntary disclosure schemes nor disclosure scores that indicate strong corporate action on climate risks are robustly associated with higher equity investments by the fund. I argue that these findings significantly undermine the argument that disclosures, in isolation, will be sufficient to allow private markets to "correctly" internalize climate risks and optimally allocate funds.

Key words: Climate-related financial disclosures, climate risks, financial regulators, low-carbon transition, Norwegian Sovereign Wealth Fund, Carbon Disclosure Project

1. Introduction

There is a growing awareness in both policy and research circles that climate change has a significant financial dimension. On the one hand, decarbonising economies around the globe will require unprecedented levels of private and public investments. On the other hand, climate change and its physical implications are the sources of novel forms of financial risks which are often not well-understood by financial markets.[1] Where unaccounted for, these risks can cause two problems. Firstly, investors may under-allocate funds towards mitigation and adaptation efforts.[2] Secondly, climate risks can accumulate on the balance sheets of institutional investors, where they can cause sharp economic readjustments and destabilise financial systems.[3] In recognition of these challenges, there has been a surge of policy action by regulators seeking to understand and address climate risks. In addition to various domestic initiatives, there are growing efforts to collaborate internationally on "greening finance", predominantly through the Network for Greening the Financial System (NGFS), which brings together a global coalition of over 80 central banks and financial supervisors.[4]

The majority of these initiatives fall into two categories.[5] Firstly, central banks have begun to examine the climate vulnerability of financial systems, mainly by conducting stress tests.[6] Secondly, regulators are encouraging the internalisation of climate risks, predominantly by promoting scenario analyses and voluntary climate-related financial disclosures (CRFDs).[7] In 2015, the Financial Stability Board launched the Task Force on Climate-Related Financial Disclosures (TCFD), which has since

[1] E. Campiglio, Y. Dafermos, P. Monnin, J. Ryan-Collins, G. Schotten, and M. Tanaka, 'Climate change challenges for central banks and financial regulators', *Nature Climate Change*, 8/6 (2018), 462–68.
[2] B. Caldecott, 'Introduction to special issue: stranded assets and the environment', *Journal of Sustainable Finance & Investment*, 7/1 (2017), 1–13; H. Chenet, J. Ryan-Collins, and F. van Lerven, 'Finance, climate-change and radical uncertainty: Towards a precautionary approach to financial policy', *Ecological Economics*, 183 (2021).
[3] S. Battiston, A. Mandel, I. Monasterolo, F. Schütze, and G. Visentin, 'A climate stress-test of the financial system', *Nature Climate Change*, 7/4 (2017), 283–88.
[4] NGFS, *Climate Change and Monetary Policy: Initial Takeaways. Technical Document*, (2020).
[5] H. Chenet, J. Ryan-Collins, and F. van Lerven, 'Finance, climate-change and radical uncertainty: Towards a precautionary approach to financial policy', *Ecological Economics*, 183 (2021).
[6] Bank of England, *Discussion Paper: The 2021 biennial exploratory scenario on the financial risks from climate change*, (2019); De Nederlandsche Bank, *Waterproof? An exploration of climate-related risks for the Dutch financial sector*, (2017).
[7] H. Chenet, J. Ryan-Collins, and F. van Lerven, 'Finance, climate-change and radical uncertainty: Towards a precautionary approach to financial policy', *Ecological Economics*, 183 (2021).

published a set of recommendations to guide corporate CRFDs. These have gained significant traction, with over 110 regulators around the globe publicly endorsing their recommendations.[8] Increasingly, CRFD requirements are also discussed as building blocks of mandatory corporate reporting requirements. In late 2020, the UK government was the first to publicly announce that it would make TCFD-aligned disclosures mandatory by 2025.[9] In 2021, the European Union (EU) followed suit by proposing its own framework for CRFDs, and the Biden administration announced plans to develop federal rules on climate-related disclosures.[10]

One of the core policy rationales which underpins this push for disclosure requirements is the notion that forcing companies to publish CRFDs allows investors to evaluate their climate risk exposure, identify "green" investment opportunities and re-allocate capital accordingly.[11] However, the existing research on climate disclosures does not provide a clear picture of whether this expectation is likely to be fulfilled. Various theoretical works provide competing arguments about how investors may react to CRFDs. Empirical studies have primarily focused on examining the impact of disclosures on firm-level metrics, e.g. share prices or the cost of equity, and arrived at inconclusive results. Somewhat surprisingly, little work has focused on the investor perspective and investigated how particular funds respond to disclosures in their investment decisions.

This paper addresses this gap by investigating the influence of firm-level disclosures on the investment decisions of a single investor: the Norwegian Sovereign Wealth Fund (NWF). Building on a novel dataset that matches the 2018 and 2019 equity portfolios of the NWF with disclosure scores awarded by the Carbon Disclosure Project (CDP) and firm-level economic data, I investigate how the NWF reacts to firms' disclosures. More specifically, I test two of the core hypotheses which underlie current policy approaches to CRFDs, namely that investors value the transparency of firms who opt to disclose and that they re-allocate funds towards firms that measure and seek to minimize their climate risk exposure i.e., conduct business with a higher degree of

[8] TCFD, *2020 Status Report*, (2020).
[9] HM Treasury, 'Chancellor sets out ambition for future of UK financial services', (2020).
[10] H. Jones, 'EU defends its push for rules on company "green" reporting', (2021); The White House, 'Executive Order on Climate-Related Financial Risk', (2021).
[11] M. Carney and M. Bloomberg, 'How to make a profit from defeating climate change', (2016).

climate risk stewardship. My analysis, which employs a combination of cross-sectional regressions, fixed-effects panel estimators and difference-in-difference models, concludes that the data offer no evidence that, in the period considered, either of the two hypotheses holds. Neither participation in voluntary disclosure schemes nor disclosure scores that indicate strong corporate action on climate risks are robustly associated with higher equity investments by the NWF in a particular firm. I argue that these findings significantly undermine the argument that disclosures, in isolation, will be sufficient to allow private markets to "correctly" internalize climate risks and optimally allocate funds.

This paper proceeds in 6 sections. Section 2 reviews the existing literature on CRFDs and identifies the gap this paper aims to address. Section 3 outlines the research design employed, discussing the case selection, the research question and hypothesis that guide my work, and the dataset and analytical strategy employed. Section 4 summarises the key results and argues that these do not support either of the two investigated hypotheses. Section 5 builds on the existing literature to derive plausible explanations for these results and outlines critical policy implications and avenues for future research. Section 6 concludes.

2. Literature Review

2.1. Research landscape on climate-related financial disclosures

Climate-related financial disclosures have received a growing amount of academic attention since the late 2000s. A systematic review conducted by Hahn et al. usefully divides the field into three streams of literature (see Figure 1).[12] The first set of studies investigates the so-called boundary conditions of disclosures, primarily by studying how the regulatory setting influences disclosure practices and how this setting has

[12] R. Hahn, D. Reimsbach, and F. Schiemann, 'Organizations, Climate Change, and Transparency: Reviewing the Literature on Carbon Disclosure', *Organization & Environment*, 28/1 (2015), 80–102.

evolved.[13] A second stream focuses predominantly on studying the determinants of disclosure decisions.[14] A third branch of the literature has focused predominantly on studying disclosure's economic and ecological outcomes.[15]

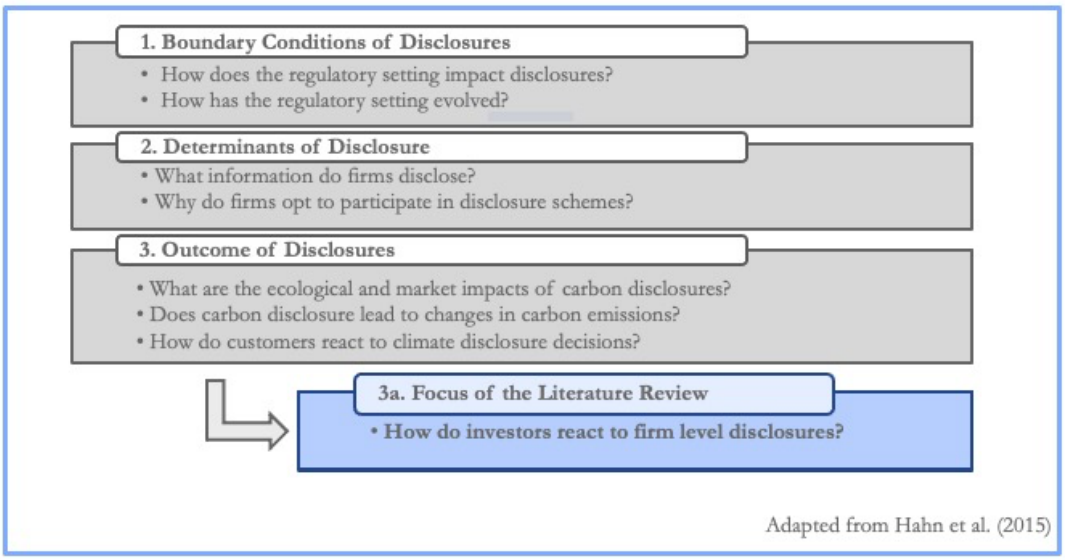

Figure 1 The three streams of climate-related financial disclosure research with exemplary research questions

In this context, it is this last stream of literature and, more specifically, the work of authors who focus on investors' reactions to firm-level disclosure decisions, which is of relevance. The following review examines the theoretical and empirical studies in this third stream and argues that the existing literature provides a mixed picture. There is an

[13] J. Andrew and C. Cortese, 'Accounting for climate change and the self-regulation of carbon disclosures', *Accounting Forum*, 35/3 (2011), 130–38; J. F. Green, 'Private Standards in the Climate Regime: The Greenhouse Gas Protocol', *Business and Politics*, 12/3 (2010), 1–37; J. Knox-Hayes and D. L. Levy, 'The politics of carbon disclosure as climate governance', *Strategic Organization*, 9/1 (2011), 91–99.
[14] S. Berthelot and A.-M. Robert, 'Climate Change Disclosures: An Examination of Canadian Oil and Gas Firms', *Issues In Social And Environmental Accounting*, 5/2 (2011); C. Chu, B. Chatterjee, and A. Brown, 'The current status of greenhouse gas reporting by Chinese companies: A test of legitimacy theory', *Managerial Auditing Journal*, 28/2 (2013), 114–39; I. Gallego-Álvarez, L. Rodríguez-Domínguez, and I.-M. García-Sánchez, 'Study of some explanatory factors in the opportunities arising from climate change', *Journal of Cleaner Production*, 19/9 (2011), 912–26; E. Stanny, 'Voluntary Disclosures of Emissions by US Firms', *Business Strategy and the Environment*, 22/3 (2013), 145–58; E. Stanny and K. Ely, 'Corporate environmental disclosures about the effects of climate change', *Corporate Social Responsibility and Environmental Management*, 15/6 (2008), 338–48.
[15] See e.g. E.-H. Kim and T. Lyon, 'When Does Institutional Investor Activism Increase Shareholder Value?: The Carbon Disclosure Project', *The B.E. Journal of Economic Analysis & Policy*, 11/1 (2011); D. C. Matisoff, 'Different rays of sunlight: Understanding information disclosure and carbon transparency', *Energy Policy*, 55 (2013), 579–92; E. M. Matsumura, R. Prakash, and S. C. Vera-Muñoz, 'Firm-Value Effects of Carbon Emissions and Carbon Disclosures', *The Accounting Review*, 89/2 (2014), 695–724.

ongoing theoretical debate about whether disclosures can significantly change how investors allocate capital, and empirical studies have arrived at conflicting results. Furthermore, most studies have sought to address this picture by focusing on the impact of disclosures on broad metrics such as share prices or a company's cost of capital, which capture the cumulative impact of all market reactions to disclosures. The perspectives and behaviour of individual investors, on the other hand, have received surprisingly little academic attention, which presents an essential gap in the existing literature.

2.2. The Theoretical Debate

Within the academic literature on investor behaviour, there is an ongoing debate on the potential for disclosures to impact how investors allocate capital. On the one hand, scholars have pointed to various channels through which climate change can be a source of financial risk to argue that investors should be sensitive to information included in CRFDs.[16] Firstly, there are the physical risks. Changing climatic conditions and the associated increase in the frequency of extreme weather events can disrupt trading patterns, create insurance liabilities, or otherwise directly impact the value of financial assets. Secondly, a series of transition risks stem from the government and market reactions to the climate challenge. These include, for example, the risks of fossil-fuel assets becoming stranded due to changes in climate policies or technological developments.[17] Where financial institutions are exposed to such assets, these risks can have a material impact on investment performance.[18] Many authors and policymakers have argued that such risks are material but currently undervalued by markets, as investors have a limited understanding of their exposures to these risks.[19] From this perspective, climate disclosures are regarded as crucial tools that could allow markets

[16] M. Carney, 'Breaking the Tragedy of the Horizon – Climate change and financial stability', (2015).
[17] See e.g. J.-F. Mercure, H. Pollitt, J. E. Viñuales, N. R. Edwards, P. B. Holden, U. Chewpreecha, P. Salas, I. Sognnaes, A. Lam, and F. Knobloch, 'Macroeconomic impact of stranded fossil fuel assets', *Nature Climate Change*, 8/7 (2018), 588–93; F. van der Ploeg and A. Rezai, 'Stranded Assets in the Transition to a Carbon-Free Economy', *Annual Review of Resource Economics*, 12/1 (2020), 281–98.
[18] P. Bolton, M. Anderson, and F. Samama, 'Governance and Climate Change: A Success Story in Mobilizing Investor Support for Corporate Responses to Climate Change', *Journal of Applied Corporate Finance*, 28/2 (2016), 29–33.
[19] S. Battiston, 'The importance of being forward-looking: managing financial stability in the face of climate risk', *Financial Stability Review*, 23 (2019), 39–48; S. Krogstrup and W. Oman, *Macroeconomic and Financial Policies for Climate Change Mitigation: A Review of the Literature*, (2019).

to overcome an information asymmetry between investors and firms, thereby enabling the former to consider climate-related risks in their decision-making.[20]

These arguments, combined with the belief that investors will rationally seek to increase the long-term performance of their portfolios, give rise to two theoretical expectations regarding the reaction of investors to CRFDs. Firstly, it implies that investors, particularly those who operate with long time horizons, should prefer firms that participate in voluntary disclosure schemes.[21] Specifically, CRFDs should be valuable to investors because they make risks transparent that would otherwise remain opaque, and because participation in itself may signal that firms are aware of and actively minimizing their climate-related risks.[22] Secondly, it is to be expected that investors exhibit a preference for equities from firms whose disclosures reveal a lower degree of climate-related financial risks.[23] This rationale underpins current policy efforts on strengthening climate disclosures.[24]

On the other hand, various authors have pointed to competing theoretical arguments which contradict such expectations. Most importantly, it has been argued that there are market mechanisms and incentives that limit investors' ability to react to disclosed climate risks, thereby limiting the potential impact of CRFDs on investment portfolios. Firstly, scholars have posited that investors may face limited incentives to react to risks whose costs may only materialise in the long term.[25] More specifically, where investors seek to optimise their portfolios' short-run returns, potential costs that occur after decades may seem irrelevant. This mismatch of horizons can imply that

[20] I. Monasterolo, S. Battiston, A. C. Janetos, and Z. Zheng, 'Vulnerable yet relevant: the two dimensions of climate-related financial disclosure', *Climatic Change*, 145/3–4 (2017), 495–507.
[21] N. Ameli, P. Drummond, A. Bisaro, M. Grubb, and H. Chenet, 'Climate finance and disclosure for institutional investors: why transparency is not enough', *Climatic Change*, 160/4 (2019), 565–89.
[22] Matsumura, Prakash, and Vera-Muñoz, 'Firm-Value Effects of Carbon Emissions and Carbon Disclosures'.
[23] T. T. Lemma, M. Feedman, M. Mlilo, and J. D. Park, 'Corporate carbon risk, voluntary disclosure, and cost of capital: South African evidence', *Business Strategy and the Environment*, 28/1 (2019), 111–26.
[24] BEIS, *Consultation on requiring mandatory climate-related financial disclosures by publicly quoted companies, large private companies and Limited Liability Partnerships (LLPs).*, (2021); NGFS, *Adapting central bank operations to a hotter world - Reviewing some options*, (2021); TCFD, *Report of the Task Force on Climate-Related Financial Disclosures*, (2017); The White House, 'Executive Order on Climate-Related Financial Risk', (2021).
[25] Ameli, Drummond, Bisaro, Grubb, and Chenet, 'Climate finance and disclosure for institutional investors'; A. Harmes, 'The Limits of Carbon Disclosure: Theorizing the Business Case for Investor Environmentalism', *Global Environmental Politics*, 11/2 (2011), 98–119; M. Naqvi, B. Burke, S. Hector, T. Jamison, and S. Dupré, *All Swans are Black in the dark*, (2017).

divesting from assets with high climate risks may not be the optimal strategy for the utility-maximising investor.

Secondly, there are longstanding criticisms of the argument that investors react rationally to the information provided by firms. Investors can be understood to be boundedly rational actors who satisfice based on simplified understandings of realities, rather than rationally optimise based on all available information.[26] As Thomä and Chenet argue, climate risks cannot easily be captured by traditional risk models because transition scenarios are not normally distributed, and because historical data on which to base future projections is limited.[27] This can lead to systematic biases in how investors integrate information on climate risk into decision-making.

A third set of authors argues that market participants cannot internalise climate risks because such risks are characterised by deep uncertainty.[28] These scholars emphasise that the complexities and endogenous nature of climate change imply that disclosures are not sufficient to allow investors to accurately attach probabilities to the impacts or time horizon of climate risks. Again, this undermines the usefulness of traditional approaches used by investors to assess the risk exposure of their portfolios. Together, these arguments suggest that disclosures may be insufficient to provide credible and appropriate market signals to investors, casting doubt on their ability to significantly change capital allocation patterns.

Overall, the existing theoretical contributions emphasise different drivers of investment behaviour and arrive at competing conclusions regarding the potential impact of climate disclosures. In theoretical terms, it is unclear which of these sets of drivers is more important in determining investor reactions. Whilst there are theoretical grounds to expect that disclosures allow investors to place a price on carbon risks, the debate is far from resolved. Furthermore, the answer may differ depending on the

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[26] H. A. Simon, *Models of man; social and rational*, (Wiley, 1957).

[27] 'Transition risks and market failure: a theoretical discourse on why financial models and economic agents may misprice risk related to the transition to a low-carbon economy', *Journal of Sustainable Finance & Investment*, 7/1 (2017), 82–98.

[28] B. Christophers, 'Climate Change and Financial Instability: Risk Disclosure and the Problematics of Neoliberal Governance', *Annals of the American Association of Geographers*, 107/5 (2017), 1108–27; Ameli, Drummond, Bisaro, Grubb, and Chenet, 'Climate finance and disclosure for institutional investors'; J. Ryan-Collins, *Beyond voluntary disclosure: why a 'market-shaping' approach to financial regulation is needed to meet the challenge of climate change*, (2019); Chenet, Ryan-Collins, and van Lerven, 'Finance, climate-change and radical uncertainty'.

characteristics of a particular investor or the economic sector under consideration.[29] The following section reviews the existing empirical evidence for these competing claims.

2.3. An empirically mixed picture

Over the past years, there have been a growing number of attempts to examine the impact of disclosures on investor behaviour empirically. However, the existing research does not yet provide a conclusive answer to the theoretical debate. Broadly speaking, researchers have opted for one out of three different approaches to estimating the relationship between carbon disclosures and investor behaviour.

One segment of the literature has focused on investigating whether investors place a carbon premium on greenhouse gas-intensive assets. Their findings are somewhat inconsistent and only tangentially address the issue of disclosures. On the one hand, several authors have found evidence in favour of such a proposition. For example, Chava studies the impact of a firm's environmental profile on its cost of capital and finds that investors require higher expected returns on stocks from firms with substantial emissions.[30] Similarly, in their study of US financial markets, Griffin et al. find evidence that investors place a risk premium on emission-intensive firms.[31] The results by Bolton and Kacperczyk, who model the impact of firm-level emissions on stock prices both in the US and globally, also support the conclusion that financial markets exhibit a carbon premium.[32] On the other hand, several studies provide evidence that casts doubt on the existence of a carbon premium. Gallego-Álvarez, for example, examines whether carbon emissions influenced the financial performance of firms across the globe in the period of 2006-2007 and does not find a robust significant effect.[33] More recently, Monasterolo & De Angelis examine whether the risk associated with low-carbon market indices traded on American, European and global stock markets differs from risks associated with

[29] See e.g. A. Harmes, 'The Limits of Carbon Disclosure: Theorizing the Business Case for Investor Environmentalism', *Global Environmental Politics*, 11/2 (2011), 98–119

[30] S. Chava, 'Environmental Externalities and Cost of Capital', *Management Science*, 60/9 (2014), 2223–47.

[31] P. A. Griffin, D. H. Lont, and E. Y. Sun, 'The Relevance to Investors of Greenhouse Gas Emission Disclosures', *Contemporary Accounting Research*, 34/2 (2017), 1265–97.

[32] P. Bolton and M. T. Kacperczykφ, *Do Investors Care about Carbon Risk?*, ECGI Finance Working Paper No. 711/2020, (2020); P. Bolton and M. T. Kacperczykφ, *Global Pricing of Carbon-Transition Risk*, (2020).

[33] I. Gallego-Álvarez, 'Impact of CO2 Emission Variation on Firm Performance', *Business Strategy and the Environment*, 21/7 (2012), 435–54.

carbon-intensive market indices.[34] They conclude that risk premiums on low-carbon stocks decreased since the Paris Agreement and find no evidence that investors penalise carbon-intensive stocks. A study conducted by the IMF also concludes that global equity prices do not yet reflect physical risks.[35]

A second group of authors has conducted similar econometric analyses which explicitly model the impact of disclosures on share prices or a firm's cost of equity. Here, the evidence is even more conflicting. Early studies focused primarily on the impact of whether firms opt to disclose at all. For example, Kim and Lyon assess whether participation in a voluntary disclosure scheme impacts the share prices of firms included in the Financial Times Global 500 and find no statistically significant difference.[36] In their study on the carbon premium, Griffin et al. estimate the emissions of non-disclosing firms to investigate whether the carbon premium in the years 2006-2012 significantly differed between disclosing and non-disclosing firms in the US, also finding no significant effect. [37] This directly contradicts the findings of Matsumura et al., who conclude that the disclosure decision by S&P 500 firms positively impacts their valuation.[38] More recent studies have gone beyond this binary analysis and examined how the quality and content of climate disclosures impact firm valuation. Lucia et al. conclude that improved disclosures, proxied by a constructed indicator which rests on environmental disclosure scores provided by Bloomberg and data on firm-level emission intensity, are associated with a lower cost of capital for European firms.[39] Lemma et al., who use company disclosure scores provided by the Carbon Disclosure Project, arrive at a similar result in a study of South African firms.[40] Alsaifi et al., on the other hand, do not find a significant effect of disclosure ratings on the cost of equity for

[34] I. Monasterolo and L. de Angelis, 'Blind to carbon risk? An analysis of stock market reaction to the Paris Agreement', *Ecological Economics*, 170 (2020).
[35] IMF, *Global Financial Stability Report: Markets in the Time of COVID-19*, (2020).
[36] E.-H. Kim and T. Lyon, 'When Does Institutional Investor Activism Increase Shareholder Value?: The Carbon Disclosure Project', *The B.E. Journal of Economic Analysis & Policy*, 11/1 (2011)
[37] Griffin, Lont, and Sun, 'The Relevance to Investors of Greenhouse Gas Emission Disclosures'.
[38] Matsumura, Prakash, and Vera-Muñoz, 'Firm-Value Effects of Carbon Emissions and Carbon Disclosures'.
[39] A. Lucia, E. Ossola, and R. Panzica, *The Greenium matters: greenhouse gas emissions, environmental disclosures, and stock prices*, (2019).
[40] Lemma, Feedman, Mlilo, and Park, 'Corporate carbon risk, voluntary disclosure, and cost of capital'.

firms listed in the FTSE350 index.[41] Overall, the evidence provided by existing quantitative studies seeking to assess the cumulative market reactions to disclosures is ambiguous.[42]

A final, smaller segment of the literature consists of qualitative studies which explicitly focus on the perspective of investors. Solomon et al. interview representatives from 20 institutional investment firms and find that they are increasingly aware of the materiality of climate risk and directly communicate with portfolio firms to overcome the informational limits of existing climate disclosures.[43] More recently, Krueger et al. conducted a survey targeting over 400 respondents from institutional investment firms to explore the perceived implications of climate risks.[44] Their findings show that whilst climate and environmental risks are ranked lower in relative importance than other traditional sources of risks, investors perceive them to be relevant despite their uncertain time horizon. Specifically on the issue of disclosures, Ilhan et al. survey over 300 professionals at prominent investment firms to assess whether investors value climate disclosures made by firms.[45] Their results suggest that investors consider climate disclosures to be just as important as other forms of financial reporting. Christophers, on the other hand, seeks to ascertain how investors think about climate risks based on interviews and arrives at a more sobering conclusion: "There is, it seems to me, no reason to believe that the investment industry will react to changing informational indicators of climate-related risk in the way that regulatory approaches to such risk presently presume" (p. 772).[46] These qualitative studies have been crucial in shedding light on the issue of disclosures from the perspectives of the investor. However, they share the common limitation that they do not link investor perceptions and statements to

[41] 'Carbon disclosure and financial performance: UK environmental policy', *Business Strategy and the Environment*, 29/2 (2019), 711–26.
[42] K. Alsaifi, M. Elnahass, and A. Salama, 'Carbon disclosure and financial performance: UK environmental policy', *Business Strategy and the Environment*, 29/2 (2020), 711–26.
[43] J. F. Solomon, A. Solomon, S. D. Norton, and N. L. Joseph, 'Private climate change reporting: an emerging discourse of risk and opportunity?', *Accounting, Auditing & Accountability Journal*, 24/8 (2011), 1119–48.
[44] P. Krueger, Z. Sautner, and L. T. Starks, 'The Importance of Climate Risks for Institutional Investors', *The Review of Financial Studies*, 33/3 (2020), 1067–1111.
[45] E. Ilhan, P. Krueger, Z. Sautner, and L. T. Starks, *Climate Risk Disclosure and Institutional Investors*, (2020).
[46] B. Christophers, 'Environmental Beta or How Institutional Investors Think about Climate Change and Fossil Fuel Risk', *Annals of the American Association of Geographers*, 109/3 (2019), 754–74.

behaviour, providing little evidence on whether observed investment decisions align with stated preferences.

2.4. The Gap

Overall, the existing literature provides a mixed picture, both at the theoretical and the empirical level. A critical gap in the existing work is that few studies focus explicitly on the investor level and examine how individual investors react to carbon disclosure decisions made by firms. This is surprising, particularly given that investors are generally recognised as a heterogeneous set of actors. Various authors have pointed to reasons why investors may differ in the extent to which they pay attention to climate risks in their decisions.[47] Harmes, for example, argues that different types of institutional investors (e.g. investment companies, pension funds, insurers) face different internal incentive structures, which may shape if or how climate risks are considered.[48] Similarly, the results presented in the study by Ilhan et al. indicate that there are systematic differences on whether climate disclosures are valued, depending on firm characteristics, investor characteristics and investor beliefs.[49] To date, this issue has received limited empirical attention.

3. Research Design

3.1. Overview

This paper addresses this gap in the literature through a quantitative case study of the Norwegian Sovereign Wealth Fund (NWF). It reverses the logic of existing studies that capture the cumulative effect of all market reactions to climate disclosures by modelling their impact on share prices of different firms and instead directs attention towards the reactions of one specific investor. This research, therefore, provides a first step towards

[47] Harmes, 'The Limits of Carbon Disclosure'; B. Zwergel, A. Wins, and C. Klein, 'On the heterogeneity of sustainable and responsible investors', *Journal of Sustainable Finance & Investment*, 9/4 (2019), 282–94.
[48] Harmes, 'The Limits of Carbon Disclosure'.
[49] Ilhan, Krueger, Sautner, and Starks, *Climate Risk Disclosure and Institutional Investors*.

creating a more nuanced understanding of investor responses to disclosures. Importantly, given the characteristics of the chosen case, it offers a useful "plausibility probe" of the policy rationale, which underlies the push for disclosures. This chapter introduces my research design, beginning with a brief note on case selection before deriving the research question and hypotheses and describing the dataset and methodology employed. It ends with a reflection of the scope and limitations of the study.

3.2. Case Selection

The Norwegian Sovereign Wealth Fund (NWF), formally called the Government Pension Fund Global, is one out of two sovereign pension funds owned by the Norwegian government. It provides an interesting case to examine in this context for two main reasons. Firstly, it is an empirically relevant case due to its size and close link to Norwegian fossil fuel production. The NWF was established by the Norwegian government in 1990, with the primary goal of creating a vehicle to reinvest the public income generated through Norwegian oil production.[50] With a market value of roughly $1.3 trillion, the fund is the world's second-largest institutional investor. Around 70% of its total assets are invested into company equities, meaning that the fund alone accounts for roughly 1.5% of the global equity market.[51] Given its public nature and close ties to Norwegian fossil fuel production, there have been longstanding debates in Norway regarding how its funds should be invested.[52] It is, therefore, empirically interesting to examine the extent to which climate disclosures shape NWF investment decisions.[53]

In addition, there are strong reasons to assume that the NWF is a "most-likely" case, in that it falls amongst those investors whom one would expect to react to disclosures by shifting capital towards assets with less climate risk. Harmes (2011) hypothesises that climate risks will primarily be considered by investors who can distance themselves from short-term performance measures or who face significant

[50] G. L. Clark and A. H. B. Monk, 'The Legitimacy and Governance of Norway's Sovereign Wealth Fund: The Ethics of Global Investment', *Environment and Planning A: Economy and Space*, 42/7 (2010), 1723–38.
[51] T. Solsvik, 'Norway wealth fund may move $50 billion into U.S. stocks from Europe', (2020).
[52] R. Milne, 'Norway's new oil fund chief seeks more ESG-driven divestments', (2020).
[53] B. J. Richardson, 'Sovereign wealth funds and the quest for sustainability: Insights from Norway and New Zealand', *Nordic Journal of Commercial Law*, 2 (2011), i–27.

public scrutiny. As a sovereign wealth fund, the NWF's *raison d'être* is to insure against long-term economic swings of the Norwegian economy, and it is subject to considerable public pressures. Both factors are embedded in its mandate, which requires the fund to be transparent in its decision-making, pay attention to long time horizons and integrate environmental, social and corporate governance considerations in its investment management activities.[54] The fund strongly emphasises the importance of long time horizons and has actively sought to position itself as a "responsible" investor.[55] On climate change issues, the fund calls on companies to integrate relevant risks and opportunities into their corporate strategy and stresses the importance of disclosures. It further pursued a highly publicised divestment campaign in 2020, in which it sold all stakes in mining and power companies that derive at least 30% of their revenues from coal mining or coal-based power production.[56] Given its position as a "most-likely" case, an analysis of the NWF provides a useful "plausibility probe" of whether disclosures can change how capital is allocated.[57]

3.3. Research Question & Hypotheses

Building on the identified gap, this paper addresses the question:

RQ: How does the NWF react to firm-level climate disclosures?

As discussed in the literature review, the current regulatory push for climate disclosures rests on two crucial assumptions. The first is that investors value transparency of risks and are therefore more likely to channel investments towards companies that participate in voluntary risk disclosure schemes. This expectation gives rise to the first research hypothesis investigated here:

H1: The NWF invests more into companies that participate in voluntary climate disclosures than into comparable firms which do not.

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[54] Norwegian Ministry of Finance, *Management mandate for the Government Pension Fund Global*, (2019).
[55] NWF, 'Investment strategy', (2018).
[56] Milne, 'Norway's new oil fund chief seeks more ESG-driven divestments'; NWF, 'Climate change', (2021); NWF, 'About the fund', (2019); NWF, 'Divestments', (2019).
[57] G. King, R. O. Keohane, and S. Verba, *Designing Social Inquiry*, STU-Student edition ed. (Princeton University Press, 1994).

The second assumption is that investors value environmental stewardship and therefore exhibit a preference for firms whose disclosures reveal either low levels of climate risk, or a high degree of climate risk awareness and a willingness to take action to mitigate exposure. This provides the reasoning underlying the second hypothesis tested here:

H2: All else equal, the NWF invests more in companies exhibiting a higher level of stewardship of climate risks.

3.4. Dataset

To investigate these hypotheses, I constructed three overlapping datasets combining global firm-level data from the following three different sources: the Norwegian Sovereign Wealth Fund, the Carbon Disclosure Project (CDP), and Standard & Poor's Market Intelligence Platform Capital IQ (CapIQ).

Firstly, I used data on the complete composition of the NWF's equity portfolio, which it publishes annually.[58] This data contained the primary dependent variable of interest, namely the size of equity holdings and the ownership stake of the fund in any individual firm and information on the sector, country, and region in which the firm is incorporated. To assess companies' disclosure behaviour and climate risk stewardship, I used disclosure scores awarded by the CDP, a non-profit charity founded in 2000, which provides a voluntary mechanism through which firms can disclose their emissions and climate risks. In 2018, the CDP redesigned its questionnaire to align with align with TCFD recommendations, creating the largest TCFD-aligned database on climate-related financial information. In 2020, a total of 9,617 firms, worth over 50% of global market capitalisation, disclosed via the CDP.[59] Its annual scores are awarded based on companies' responses to a survey and a scoring methodology which is designed to reflect both whether a company disclosed or not, as well as the organisation's self-reported awareness and management of climate risks.[60] These are commonly regarded as one of the most credible ratings of corporate environmental

[58] NWF, 'Investments', (2021).
[59] CDP, 'Press Release - CDP reports record disclosures, despite Covid-19, as corporate environmental action rises', (2020); K. Alsaifi, M. Elnahass, and A. Salama, 'Carbon disclosure and financial performance'.
[60] CDP, 'Companies Scores', (2021).

disclosure practices and have frequently been used in academic research.[61] In this context, these scores can therefore be used as a meaningful proxy for both disclosure participation and environmental risk stewardship.[62] Finally, I gathered additional annual controls from CapIQ, a market intelligence platform, which provides firm-level data on equities and balance sheets.

The individual sources and key variables derived from each are outlined in Table 1. The first two datasets derived from these sources are cross-sectional, containing firm-level observations from the years 2018 and 2019, respectively. The third is a panel dataset spanning both years. I decided to focus on the years 2018 and 2019 to ensure that the data reflects the latest methodological changes made by the CDP but is not biased by the economic disruptions of the CoVid-19 pandemic.[63]

To compose my datasets, I joined the NWF portfolios of the years 2018-2020 and matched individual firms with the 2018 and 2019 firm-level disclosure scores provided by the CDP. In a subsequent step, I gathered a series of control variables by linking company names to stock tickers and matching these to firm-level data via CapIQ. The choice of controls was derived both from the existing literature and publicly available information on the fund.[64] More specifically, documents outlining the NWF's investment strategy indicate that it actively seeks to diversify exposure across regions and industries, so *Country* and *Industry* are included as fixed effects. In addition, following the existing literature, I control for a series of firm-level financial variables.[65]

The variable *Size,* measured as a firm's total economic value, accounts for the fact that company size is a likely determinant of the investment decision of the fund, given that equities of large firms tend to be more liquid, can be scaled to large trade volumes, and create fewer overhead costs in terms of research. Furthermore, given the fund's

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[61] F. Schiemann and A. Sakhel, 'Carbon Disclosure, Contextual Factors, and Information Asymmetry: The Case of Physical Risk Reporting', *European Accounting Review*, 28/4 (2019), 791–818; Alsaifi, Elnahass, and Salama, 'Carbon disclosure and financial performance'.

[62] Alsaifi, Elnahass, and Salama, 'Carbon disclosure and financial performance'.

[63] Nevertheless, NWF investment data and firm-level controls were, where available, also gathered for the year 2020 to allow for supplementary analysis (see section 3.5).

[64] NWF, *Global Investment Performance Standards Report*, (2020); regjeringen.no, 'Strategic Benchmark Index', (2018).

[65] Alsaifi, Elnahass, and Salama, 'Carbon disclosure and financial performance'; Chava, 'Environmental Externalities and Cost of Capital'; Gallego-Álvarez, 'Impact of CO2 Emission Variation on Firm Performance'.

needs to diversify and balance risks, equity investment decisions are likely to be causally linked to the company's risk profile.[66] To account for this fact, I include several variables commonly used to measure corporate risks. These are *Financial Leverage*, defined as the ratio of total debt to total equity, which captures a firm's ability to meet outstanding debt obligations; the firm's 5-year beta (*ß*), which captures the historical volatility of its share price in relation to overall market fluctuations; the *Equity Multiplier (BLev)*, defined as the ratio between total assets and total equity, which reflects the extent to which a company is relying on debt to finance assets; and the *Market to Book* ratio, calculated as the ratio of common equity to total market capitalisation, which is used to assess whether a company is under- or overvalued by the market.[67]

Table 1. Data Sources

Source	**Key Variables**
NWF *Equity Portfolio as of 31.12.2020* *Total Value: $ 931 billion* *Equity Portfolio as of 31.12.2019* *Total Value: $ 814 billion* *Equity Portfolio as of 31.12.2018* *Total Value: $ 633 billion*	- Company Name - Sector - Country - Region - Value of equity investments/company (USD)
Carbon Disclosure Project *CDP Company Scores 2019* *Total number of Firms: 7773* *CDP Company Scores 2018* *Total number of Firms: 6780*	- Company Name - Disclosure Score (Scale: A-F)
Capital IQ	- Company Name - Total Enterprise Value (USD) - Total Common Equity (USD - Total Assets (USD) - Market Capitalization (USD) - 5-year Beta - Total Debt/Equity - Gross Profits (USD)

[66] Alsaifi, Elnahass, and Salama, 'Carbon disclosure and financial performance'; NWF, *Investing in Equities*, (2020).

[67] Chava, 'Environmental Externalities and Cost of Capital'; Bolton and Kacperczykφ, *Global Pricing of Carbon-Transition Risk*; P. Bolton and M. T. Kacperczykφ, *Do Investors Care about Carbon Risk?*, ECGI Finance Working Paper No. 711/2020, (2020)

	- Return on Equity - Return on Assets

Finally, the fund's investment decisions are also likely to be influenced by companies' profitability and financial performance.[68] I therefore also control for Return on Equity (RoE) and Return on Assets (RoA). As is common in the literature, all financial variables are winsorised at 1% and 99% to avoid distortions from outliers.[69] This process removes extreme values by transforming all observations falling above the 99th percentile (or below the 1st percentile) to the value of the 99th percentile (1st percentile).

This data collection strategy allowed me to assemble three related datasets: two cross-sectional sets covering the years 2018, 2019 respectively, and a panel dataset spanning both years. Summary statistics for the key variable of interest, Equity Holdings, and financial controls are provided in Table 2.

Table 2 Summary Statistics

Dataset	**2018 Cross-section**			**2019 Cross-section**			**Panel Data**		
Variable	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev	Obs.	Mean	Std. Dev
Equity Holdings (USD)	5701	6.03E+07	1.45E+08	5565	7.74E+07	1.88E+08	9632	7.60E+07	1.78E+08
Ownership (%)	5701	1.18	0.85	5565	1.20	0.88	9632	1.19	0.87
Size (USD)	5701	7.74E+09	1.70E+10	5565	9.68E+09	2.12E+10	9632	1.10E+10	3.80E+10
FLev (%)	5701	0.84	1.21	5565	0.77	1.04	9632	0.79	0.79
MtB (%)	5701	0.88	0.85	5565	0.81	0.84	9632	0.83	0.83
BLev (%)	5701	2.74	2.81	5565	3.04	3.68	9632	2.85	2.54
RoE (%)	5701	0.15	0.52	5565	0.18	0.81	9632	0.13	0.13
RoA (%)	5701	0.07	0.36	5565	0.04	0.05	9632	0.04	0.04
ß (2021)	5701	1.01	0.61	5565	1.00	0.60	N.A.		

[68] Alsaifi, Elnahass, and Salama, 'Carbon disclosure and financial performance'; NWF, *Investing in Equities*.
[69] See e.g. Chava, 'Environmental Externalities and Cost of Capital'; Lemma, Feedman, Mlilo, and Park, 'Corporate carbon risk, voluntary disclosure, and cost of capital'.

Because controls could not be gathered for all firms or across both years, the firms in each dataset overlap but do not perfectly align.[70] Nevertheless, the samples cover a sizable proportion of the NWF's portfolio, with the included firms accounting for at least 67% of the portfolio's total market value in each year. Table 3 summarises the distribution of CDP scores across the entire 2018 and 19 portfolios.

At this stage it is interesting to note that in both years the share of firms assessed by the CDP was relatively small: only 18.8% of firms in the 2018 portfolio and 20.4% of firms in the 2019 portfolios disclosed via the CDP. Nevertheless, the equity holdings of these firms made up a significant share of that year's total portfolio value, namely 59.7% and 61.5%, respectively.[71] At this stage, it remains unclear whether this phenomenon is simply a spurious association resulting from external factors that impact both the fund's investment decisions and disclosures, or whether there may be a causal relationship between the size of equity holdings and CDP disclosures of the firm. The subsequent section outlines the analytical strategy employed to unpack the relationship between these two variables.

[70] There are several reasons why controls could not be gathered for all firms in the portfolio. In some cases, data were unavailable because the respective firm filed for bankruptcy or went private since the time of observation and could no longer be linked to a stock ticker. In other cases, data was not available via CapIQ.

[71] For this research, firms receiving an F were grouped with companies not assessed by the CDP (see Table 3)

Table 3. Distribution of CDP Scores in the NWF Portfolio

Score	# of Firms (2018)	Market value share of the total portfolio (2018)	# of Firms (2019)	Market value share of the total portfolio (2019)
A	127	12.09%	166	13.37%
A-	222	13.46%	292	13.96%
B	469	13.61%	604	18.79%
B-	81	1.40%	94	1.76%
C	455	14.00%	457	9.33%
C-	2	0.01%	3	0.03%
D	323	4.48%	216	3.26%
D-	39	0.60%	35	0.54%
F	2062	22.18%	2164	22.84%
Not Scored	5377	18.17%	5171	16.11%
Total	9157	100%	9202	100%

Note The scores assess a company's progress towards environmental stewardship and can be interpreted as follows [72].

A & A-: Leadership Level. Awarded to firms whose responses demonstrate that they follow best practices on environmental stewardship, have a thorough understanding of climate-related risks and opportunities, and have formulated and implemented strategies to mitigate or capitalise on these.

B & B-: Management Level. Awarded to firms whose disclosures provide evidence that the company actively seeks to reduce its negative climate impact and mitigate climate-related risks.

C & C-: Awareness Level. Awarded to firms whose responses showcase that the company has a comprehensive understanding of their climate impact and the repercussions of climate change on their business model.

D & D-: Disclosure Level. Awarded to firms whose survey responses are adequately comprehensive and provide sufficient information to be evaluated.

F: Failure to provide sufficient information. The CDP assigns 'F' to companies who fail to provide sufficient information to be evaluated. The score, therefore, indicates poor disclosure practices which is why, in the context of this research, an F is deemed equivalent to non-disclosure.

These scores are progressive, meaning that only firms whose disclosures meet a minimum threshold for lower scores can be considered for higher scores.

[72] See CDP, *Scoring Introduction 2021*, (2021); CDP, 'Companies Scores'.

3.5. Analytical Strategy

My analysis focused on the two hypotheses outlined above in turn. The models and necessary robustness checks employed for both parts of the analysis are described below.

3.5.1. Hypothesis I

The first hypothesis posits that the NWF invests more into companies that participate in voluntary climate disclosures than into comparable firms that do not. Assessing the impact of CDP participation on the fund's equity holdings is challenging due to the risks posed by omitted variables. As the literature on the determinants of firm participation in voluntary disclosure schemes has shown, CDP participation is non-random. For example, company size, regulatory pressure, and the carbon-intensity of the industry are likely to influence the choice of participating in carbon disclosure schemes.[73] It cannot be ruled out that some of these variables, such as quality of management, also directly impact the NWF's investment decisions, thereby creating risks of endogeneity. To avoid this risk of bias, I followed a three-step analytical procedure which combines cross-sectional analyses with panel data models and difference-in-difference (DID) estimators.

A. Cross-sectional Analysis

In a first step, two cross-sectional OLS models were estimated to arrive at a preliminary assessment of whether participation in CDP disclosures has a significant positive association with the value of NWF equity holdings in that firm in the years 2018 and 2019, respectively.

[73] I. Gallego-Álvarez, L. Rodríguez-Domínguez, and I.-M. García-Sánchez, 'Study of some explanatory factors in the opportunities arising from climate change', *Journal of Cleaner Production*, 19/9 (2011); J. Grauel and D. Gotthardt, 'The relevance of national contexts for carbon disclosure decisions of stock-listed companies: a multilevel analysis', *Journal of Cleaner Production*, 133 (2016), 1204–17; Hahn, Reimsbach, and Schiemann, 'Organizations, Climate Change, and Transparency'; Kim and Lyon, 'When Does Institutional Investor Activism Increase Shareholder Value?'; E. Stanny, 'Voluntary Disclosures of Emissions by US Firms', *Business Strategy and the Environment*, 22/3 (2013), 145–58;

Model 1 CDP Participation 2018

$$(1)\ ln(EH)_{i,2018} = \alpha + \beta_1 CDP_{Binary_{i,2018}} + \beta_2\, ln(Size)_{i,2018} + \beta_3 FLev_{i,2018} + \beta_4 MtB_{i,2018} + \beta_5 BLev_{i,2018} + \beta_6 RoE_{i,2018} + \beta_6 RoA_{i,2018} + \beta_7 country_{fe} + \beta_8\, industry_{fe} + \epsilon_i$$

Model 2 CDP Participation 2019

$$(2)\ \boldsymbol{ln(EH)_{i,2019} = \alpha + \beta_1 CDP_{Binary_{i,2019}} + \beta_2\, ln(Size)_{i,2019} + \beta_3 FLev_{i,2019} + \beta_4 MtB_{i,2019} + \beta_5 BLev_{i,2019} + \beta_6 RoE_{i,2019} + \beta_6 RoA_{i,2019} + \beta_7 country_{fe} + \beta_8\, industry_{fe} + \epsilon_i}$$

In both models, ln(EH_i) measures the logged market value of the equity holdings for each firm *i* in the sample at the end of 2018 and 2019. Both equity holdings and the variable *Size* were logged to address the significant skew in equity holdings and company size and account for the expectation that many of the relationships between the included controls, e.g. *FLev,* and *EH* are likely multiplicative rather than linear. The key explanatory variable of interest is CDP_{Binary}, a dummy variable for whether the CDP scored the firm. The remaining variables are the controls outlined above and country and industry fixed effects.

Several robustness checks were employed to assess the reliability of these results. Firstly, the specification was altered by changing the dependent variable to *Ownership*, which measures the share of the firm's total outstanding shares owned by the NWF. The benefit of this specification is that it is less likely to be impacted by the broader market valuation of share prices, providing a more exact proxy of strategic investment decisions made by the fund. Secondly, the models were fit using non-logged values to assess the sensitivity of core conclusions to alternative model specifications. In addition, I included interaction terms between CDP participation and Industry, Size and Region, to account for the expectation that reasons for joining the CDP may differ across firms in different industries and countries, or between small and large firms. Thirdly, I replaced *RoE* and *RoA* with 1-year profit and revenue growth measures as alternative controls for a firm's financial performance. Finally, I estimated both models using the subsequent year's portfolio data to assess the possibility of a delayed effect. The primary rationale behind

this test is that the CDP tends to publish its scores in either December or January. Although the scores reflect the quality of financial disclosures spanning the entire year, they are not immediately publicly available. If the fund, therefore, directly uses CDP data to indicate disclosure performance, the effect may only be reflected in the portfolio composition at a later point in time.

B. Panel Analysis

In addition to the two cross-sectional analyses, I fitted two further models to address the concerns of omitted variable bias influencing the cross-sectional estimators. The first is a within estimator panel model, which leverages the availability of data spanning multiple years:

Model 3 Within Estimator Model between 2018 and 2019

$$(3)\ ln\ (EH_{i,t}) - \overline{ln\ (EH_{i,t})} = \beta_1(CDP_{Binary_{i,t}} - \overline{CDP_{Binary_{i,t}}}) + \beta_2(Controls - \overline{Controls_{i)}}) + (\epsilon_{i,t} - \epsilon_i).$$

The above model subtracts the average value of each variable over the two years, thereby removing time consistent heterogeneity across firms and lowering the risk that firm-specific effects bias the results.[74] The coefficient β_1 likely provides a more reliable indication of whether CDP participation is associated with the overall size of equity holdings of a firm than the cross-sectional models. The variable *Controls* represents the vector of controls outlined above, except for those that do not vary across time as the model controls for time-invariant confounders (i.e. country fixed effects, industry fixed effects and the 5-year beta). Again, the model's sensitivity to replacing the dependent variable with *Ownership*, including profit and revenue growth as alternative controls, and adding interaction terms, was assessed.

[74] R. C. Hill, W. E. Griffiths, and G. C. Lim, *Principles of econometrics*, Fifth Edition ed. (Wiley, 2017).

C. Difference-in-Difference Analysis

Thirdly, I conducted a difference-in-difference (DID) analysis on the subset of firms (n= 3723) that did not disclose in 2018.[75] This analysis compared the change in equity holdings of continued non-disclosers to those of firms that switched from non-disclosure in 2018 to disclosure in 2019. Essentially, this specification compares each firm to itself, therefore controlling for additional firm-level omitted variables. In addition, the DID-analysis strengthens the validity of my results by reducing the risk that my conclusions are biased by the limited time span studied. Hypothetically, it could be possible that the NWF had already perfectly accounted for disclosure behavior prior to 2018. If this was the case, Models 1-3 would show no association between the two variables. This final specification, however, would still capture the fund's reaction by isolating those firms where the disclosure participation changed between 2018 and 2019.

The estimated model looks as follows:

Model 4 Difference-in-Difference Analysis of CDP participation

$$(4)\ ln(EH) = \alpha + \delta_0 after + \beta_0 treated + \delta_1 after * treated + \beta_2(Controls) + \mu.$$

In the above equation, *treated* is a binary variable that takes the value 1 for all firms which shifted from CDP non-participation to participation between 2018 and 2019, and 0 for the remaining continued non-disclosers. The variable *after* is a binary dummy equal to 0 for all 2018 observations and 1 for all 2019 observations. The core coefficient of interest is δ_1, which provides an estimate for the treatment impact of disclosure via the CDP on the size of the fund's equity holdings in a particular firm. Crucially, this model rests on the parallel trends assumption, which holds that equity holdings would have developed similarly across all firms if no firm had disclosed.[76] The validity of this assumption in the context of this research is discussed in Section 3.6. Again, the

[75] P. J. Gertler, S. Martinez, P. Premand, L. B. Rawlings, and C. M. J. Vermeersch, *Impact Evaluation in Practice*, (2016).
[76] J. D. Angrist and J.-S. Pischke, *Mostly harmless econometrics: an empiricist's companion*, (Princeton University Press, 2009).

robustness of these results was assessed by replacing the dependent variable with *Ownership* and altering the included controls.

3.5.2. Hypothesis II

The second hypothesis holds that all else equal, the NWF invests more money into companies that exhibit a higher level of stewardship of climate risks. Again, my analysis of this second hypothesis was conducted in several steps.

A. Cross-sectional Analysis

I began by fitting two cross-sectional models which estimate the relationship between a company's CDP scores and the NWF's equity holdings in that firm in 2018 and 2019, respectively:

Model 5 CDP Scores 2018

$$(5)\ ln\ (EH)_{i,2018} = \alpha + \beta_1 CDPScore_{i,2018} + \beta_2 Controls_{2018} + \epsilon_i.$$

Model 6 CDP Scores 2019

$$(6)\ ln\ (\mathrm{EH})_{i,2019} = \alpha + \beta_1 \mathrm{CDPS}core_{i,2019} + \beta_1 Controls_{2019} + \epsilon_i.$$

The variable *CDPScore* provides a numerical reflection of the annual disclosure scores assigned to companies by the CDP. It is a continuous variable with values ranging from 0-8. Zero represents a failure to disclose or a score of F, and 8 corresponds to the score A. As higher scores indicate improved climate risk stewardship, one expects *CDPScore* to be positively associated with *ln(EH)* if H2 holds. Important robustness checks include those outlined in Section 3.5.1.1. In addition, I repeated the analysis using *CDPScore* as a categorical variable, with dummy variables representing individual scores. If H2 holds, the individual dummy coefficients should be positively associated with *ln(EH)* and exhibit a logical ordering, with higher scores being associated with relatively higher equity holdings than lower scores.

B. Panel Analysis

In addition, I again used a within estimator to reduce the risk of omitted variable bias:

Model 7 Within Estimator Model between 2018 and 2019

$$(7)\ ln\ (EH)_{i,t} - (\overline{ln\ (EH)}_{i,t}\ = \beta_1(CDPScore_{it} - \overline{CDPScore_i}) + \beta_2\big(Controls_{i,t} - \overline{Controls_i}) + (\epsilon_{it} - \epsilon_i\big).$$

This model was estimated twice, once on the complete panel data set (Model 7a) and once only on the subset of firms that already disclosed in 2018 (Model 7b) (n=1046). The rationale behind this second specification is that changes in disclosure scores over two years are a more precise indicator of whether environmental stewardship has improved or declined over time than changes from non-disclosure to disclosure. A change from non-disclosure to disclosure mainly signifies that environmental stewardship practices which were previously opaque are now more transparent.[77] This may be accompanied by an improvement in stewardship practices, but that must not necessarily be the case. Score changes of already disclosing firms, however, are directly linked to changes in stewardship over that time period. This has the added benefit of allowing me to capture a relationship between disclosure practices and equity holdings in a scenario where the fund fully accounted for climate risk exposure pre-2018. I again conducted the same robustness checks as for model 3 and estimated the models with CDPScore as both a continuous and categorical variable.

C. Difference-in-Difference Analysis

The final model used to assess H2 was a DID model, which investigates whether an improvement of the CDP Score from one year to the next is associated with higher levels of equity holdings:

Model 8 Difference-in-Difference Analysis of CDP Score improvement

$$(8)\ ln(EH) = \alpha\ +\ \delta_0 after +\ \beta_0 treated +\ \delta_1 after * treated +\ \beta_2(Controls) +\ \mu.$$

[77] CDP, *Scoring Introduction 2021.*

In this case, the variable *treated* was equal to 1 if a firm's score improved from 2018 to 2019, and the value 0 if it remained constant or declined. Like the Panel Analysis in Section 3.5.2.2., the model was fit once on the entire panel data set (Model 8a) and once on the subset of firms that disclosed in both years (Model 8b). The robustness of the results was assessed by replacing the dependent variable with *Ownership* and altering the specification of the included controls.

3.5.3. Scope and Limitations

Taken together, these models allow me to shed light on whether the development of the NWF portfolio in 2018 and 2019 lends support to the two critical working hypotheses which underlie the regulatory approach taken by the TCFD. Nevertheless, several limitations of the research design need to be kept in mind when interpreting the results outlined in section 4.

First of all, there is a remaining risk to internal validity due to omitted variable bias (OMV) and endogeneity, given the non-randomisation of the treatment variable, i.e. climate disclosures. This risk is particularly present in the cross-sectional analyses employed. Within these models, I sought to mitigate against the influence of omitted variables by controlling for several significant determinants of CDP participation identified by the literature, namely Country, Industry, and *Size*.[78] Nevertheless, the possible influence of omitted variables remains non-negligible.

The use of within estimators and DID estimators is designed to increase the reliability of findings. Within estimation reduces bias from omitted variables that are constant across time and entities.[79] Similarly, the applied DID models control for time-invariant omitted variables by comparing developments between a treatment group and a control group at two points in time.[80] Both models, however, rest on the assumption that there are no time-invariant omitted variables that are correlated with the CDP participation and scores over time. This assumption may be violated if, for example, disclosure decisions change due to entity-internal changes such as shifts in company

[78] Hahn, Reimsbach, and Schiemann, 'Organizations, Climate Change, and Transparency'.
[79] Hill, Griffiths, and Lim, *Principles of econometrics*.
[80] S. R. Khandker, G. B. Koolwal, and H. A. Samad, *Handbook on impact evaluation: quantitative methods and practices*, (World Bank, 2010).

leadership or where regional or global economic shocks in the period of study impact disclosure behaviour. For this reason, it would not have been suitable to extend the analysis to cover data from 2020, which is influenced by the economic shock of the CoVid-19 Pandemic. Theoretically, this assumption could be avoided by applying a combination of propensity score matching (PSM) and DID estimation to construct a more reliable control group.[81] However, such a design would require the creation of a model to calculate the likelihood of firms participating in the CDP or receiving a specific score. This, in turn, necessitates reliable data on a multitude of variables that are likely important determinants of CDP participation and scoring, such as quality of management. In this context, constructing a reliable propensity score model would only have been possible by severely restricting the sample to a subset of countries or sectors, which would have limited the representativeness of the findings. Therefore, the decision was made to rely on panel regressions and DID models instead to allow the analysis to arrive at meaningful conclusions regarding the influence of climate scores on the overall investment practices of the fund.

The second core limitation of this research concerns its external validity. As outlined above, the Norwegian Sovereign Wealth Fund does not reliably represent a larger set of investors.[82] However, as Dasgupta highlights in the introduction of his review of the economics of biodiversity, biased estimates can be extremely useful, provided that one knows the direction of the bias.[83] In the context of this research, there are several theoretical reasons to suggest that the NWF is more likely to take climate risk considerations into account than most other financial institutions. The results of these models offer a robust plausibility probe to assess the assumptions on which current regulatory approaches rest.

[81] Gertler, Martinez, Premand, Rawlings, and Vermeersch, *Impact Evaluation in Practice*; P. R. Rosenbaum and D. B. Rubin, 'The central role of the propensity score in observational studies for causal effects', *Biometrika*, 70/1 (1983), 41–55.
[82] P. Eriksson and A. Kovalainen, *Qualitative methods in business research*, 2. ed. ed. (SAGE Publications, 2016).
[83] S. P. Dasgupta, 'The Economics of Biodiversity: the Dasgupta Review | The Royal Society', (2021) Min 42:25.

4. Results

4.1. Hypothesis I

The results of the four core models used to assess the H1 are provided in Table 1. The two cross-sectional analyses estimate that there is, in fact, a positive and statistically significant relationship between CDP participation and the logged values of the NWF's equity holdings in a particular firm. In 2018, the model suggests that equity holdings of firms that have disclosed via the CDP are 55.27% higher than those of firms that have not disclosed. In 2019, the estimated effect is slightly lower at 49.18%. Notably, this relationship remained positive and significant at the 5% significance level across all robustness checks outlined above.[84] The only exceptions were models which included interaction terms between CDP participation and *Size*, *Region* and *Industry*. However, all the interaction terms were significant, even if the significance level of the core coefficient for CDP participation dropped below 10%. Interestingly, the models including interaction terms provided conflicting results across the two years. Whilst in both years, the results suggested that the association between the two variables increases with the firm's size, they led to conflicting estimates regarding the direction and relative ordering of the interactions effects between CDP participation and different regions and industries. Theoretically, this incongruence could be due to a shift of investment strategy in the fund between 2018 and 2019. It could, however, also indicate that there are omitted variables that co-vary with CDP participation, which bias the estimated results and cause inconsistent estimates across time.

Table 1 Hypothesis I – Results

	Cross-sectional Models		**Within Estimator**	**DID**
Model	1	2	3	4
Dependent Variable	$\ln(EH)_{2018}$	$\ln(EH)_{2019}$	$\ln(EH_{i,t}) - \overline{\ln(EH_{i,t})}$	ln(EH)
	Coefficient (Std. Dev.)	Coefficient (Std. Dev.)	Coefficient (Std. Dev.)	Coefficient (Std.Dev.)
CDP_{Binary}	0.44 (0.04)***	0.40 (0.04)***	0.04 (0.06)	No

[84]Given the word count limitation, the results of the individual robustness checks are not reported here, but the complete datasets are submitted as supplementary information.

ln(Size)	0.79 (0.01)***	0.83 (0.01)***	0.54(0.03)***	0.79 (0.01) ***
Flev	-0.24 (0.01)***	-0.22 (0.02) ***	0.12 (0.03) ***	-0.28 (0.02)***
Mtb	-0.19 (0.02)***	-0.11 (0.02)***	-0.13 (0.02)***	-0.27 (0.02)***
Blev	0.05 (0.01) ***	0.01 (0.00) **	-0.01 (0.01)	0.04 (0.01) ***
RoE	0.06 (0.03)*	0.01 (0.02)	0.03 (0.04)	0.08 (0.05)
RoA	-0.06 (0.05)	2.09 (0.30) ***	0.98 (0.45)**	2.03 (0.36)***
Beta	-0.03 (0.03)	-0.05 (0.03) *	No	No
Country Fe	Yes	Yes	No	No
Industry Fe	Yes	Yes	No	No
Treated	No	No	No	0.51 (0.10)***
After	No	No	No	-0.02 (0.03)
*After*Treated*	No	No	No	-0.02 (0.15)
N	5701	5565	9632	7446
R^2	0.683	0.704	Within = 0.085	0.524
Adj. R^2	0.678	0.700	Between = 0.616	0.524
			Overall = 0.584	

* 10 % significance; ** 5% significance; *** 1% significance.

The results of the panel and difference-in-difference analyses lend weight to the latter interpretation. In Model 3, the coefficient of CDP_{Binary} is positively associated with logged equity holdings, but this result is not statistically significant at the 10% level. Neither changing the specification to *Ownership* nor altering the included controls and fitting the model on non-logged values led to estimated significant effects. In contradiction to the findings outlined above, these results suggest that once firm-specific effects are controlled for, there is no significant association between CDP participation and the size of the fund's equity holding or the percentage of shares it owns in a firm. Similar results are provided by the DID estimator, which compares the difference in how equity holdings developed over time between firms that did not disclose in either year to those which switched from non-disclosure to disclosure 2019. The core coefficient of interest, *after * treated*, is negative and insignificant, indicating no treatment effect. These results are visualized in Figure 2, which shows that fitted values of equity holdings over time developed in a largely parallel fashion between the two groups.

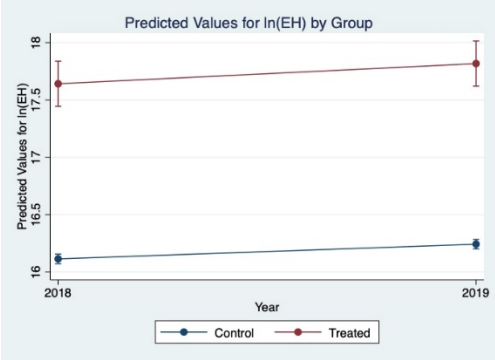

Figure 2 Model 4 - Predicted Values

The only alternate specification in which the model estimated a significant positive effect was when it was fit on the non-logged values of *Size* and *Equity Holdings*. However, a study of the residual plots of these two models (see

Figure 3 Model 4 – Residual Plot with Log- transformation and

Figure **4**) reveals that the logarithmic transformation greatly improves the fit of the model by reducing heteroskedasticity, lending weight to its findings. In line with the panel estimator, the DID analysis, therefore, suggests that in the period considered, firm-level decisions to shift from non-disclosure to disclosure are not associated with an increase in equity holdings by the NWF in that firm.

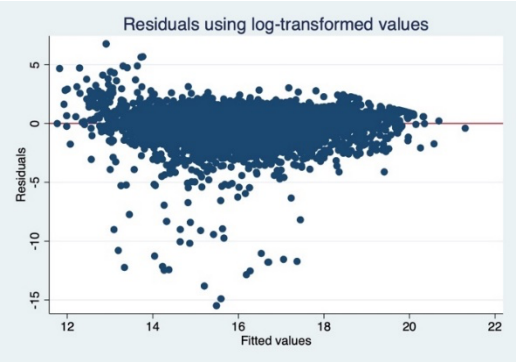

Figure 3 Model 4 – Residual Plot with Log- transformation

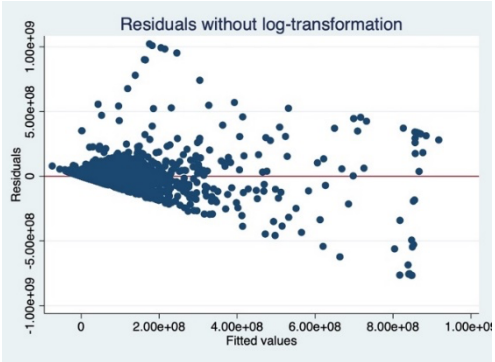

Figure 4 Model 4 - Residual Plot without Log-transformation

Overall, this analysis indicates that there is little evidence to suggest that in 2018 and 2019, the NWF consistently invested more money into companies after they disclosed their climate risks through CDP. Whilst the cross-sectional models indicated

such an association, both the panel and DID suggest that this may be driven by unobserved omitted variables which influence both the NWF's decision to purchase equities in a particular firm and the firm's decision to participate in the disclosure scheme. For example, the fund may be shifting investments towards firms led by a strategic, forward-looking leadership team, and it is only coincidental that, given the rise of climate risk on the international agenda, these firms also decide to participate in voluntary disclosures at the same time.

4.2. Hypothesis II

The results of the core models applied to assess H2 are summarised in Table 2. If H2 holds, we would expect to find a positive association between the continuous variable *CDP Score* and the fund's *Equity Holdings* or *Ownership* stake in a particular firm. As above, the cross-sectional models suggest that there is a statistically significant positive association between score and equity holdings in both 2018 and 2019. This finding remained essentially robust across the different model specifications. When including *CDP Score* as a categorical variable, the term remained significant in both years, but the relative ordering of coefficients did not align with expectations. The 2018 cross-sectional analysis, for example, estimated that all else equal, the NWF holds more equity in firms that received a D-, than in companies that did not disclose. However, it also estimated that it holds less equity in firms that received a C- than in non-disclosing firms. A closer examination of the data reveals that this inconsistency could be linked to the low statistical power of some individual score coefficients, given that there are individual scores with few observations (e.g. in 2018, only two firms in the sample received a C-). When grouping observations that received the same letter score (i.e. A & A-), the relative ordering of the coefficients primarily aligned with the expected ordering, with better scores being associated with higher levels of *EH*.

Table 2 Hypothesis II – Results

	Cross-sectional Models		Within Estimator		DID	
Model	**5**	**6**	**7a**	**7b**	**8a**	**8b**
Dependent Variable	$\ln(EH)_{2018}$	$\ln(EH)_{2019}$	$ln\,(EH_{i,t}) - \overline{ln\,(EH_{i,t}}$	$ln\,(EH_{i,t}) - \overline{ln\,(EH_{i,t}}$	ln(EH)	ln(EH)
	Coefficient (Std. Dev.)	Coefficient (Std. Dev.)	Coefficient (Std. Dev.)	Coefficient (Std. Dev.)	Coefficient (Std. Dev.)	Coefficient (Std. Dev.)
CDP Score	0.08 (0.01)***	0.07 (0.01)***	0.01 (0.01)	0.02 (0.01)*	No	No
ln(Size)	0.78 (0.01)***	0.83 (0.01)***	0.54 (0.03)***	0.45 (0.04) ***	0.85 (0.01)***	0.85 (0.01) ***
Flev	-0.24 (0.01)***	-0.22 (0.02)***	0.12 (0.03) ***	0.11 (0.03)***	-0.28 (0.01)***	-0.22 (0.18)***
MtB	-0.20 (0.02)***	-0.11 (0.02)***	-0.13 (0.02)***	-0.14 (0.04)***	-0.25 (0.02) ***	-0.18 (0.03)***
Blev	0.05 (0.01)***	0.01 (0.00)**	-0.01 (0.01)	0.03 (0.01) ***	0.04 (0.01) ***	0.02 (0.01) ***
RoE	0.06 (0.03)**	0.01 (0.02)	0.03 (0.04)	0.10 (0.05)**	0.05 (0.04)	-0.00 (0.05)
RoA	-0.06 (0.05)	2.13 (0.30)***	0.98 (0.45)**	2.41 (0.72) ***	2.06 (0.31)***	2.00 (0.54)***
Beta	-0.03 (0.03)	-0.05 (0.03)*	No	No	No	No
Country fe	Yes	Yes	No	No	No	No
Industry fe	Yes	Yes	No	No	No	No
Treated	No	No	No	No	0.33 (0.05)***	-0.08 (0.05)
After	No	No	No	No	-0.02 (0.03)	0.03 (0.04)
*After * Treated*	No	No	No	No	0.01 (0.08)	-0.02 (0.07)
N	5701	5565	9632	1046	9632	2092
R^2	0.683	0.704	Within = 0.085	Within = 0.147	0.627	0.722
Adj. R^2	0.678	0.700	Between = 0.617	Between = 0.642	0.627	0.72
			Overall = 0.5844	Overall = 0.620		

Again, however, the results of the panel and DID models do not support the findings of the cross-sectional analysis. Neither of the two within-estimator models provides strong evidence in favour of the conclusion that, when controlling for firm-specific effects, increased CDP scores are associated with higher levels of equity holdings. In Model 7a, which was estimated on the entire panel dataset, the coefficient was positive yet insignificant. This was confirmed across the different robustness checks. Model 7b, which only considered the firms that disclosed in both years, estimates a weakly significant effect (p = 0.059) in my main specification. This, however, was not robust to different model specifications. When using Ownership as my dependent variable, for example, the coefficient became negative and lost significance. Similarly, the coefficient for CDP Score lost significance when changing the included controls or including CDP Score as a categorical variable. The panel estimates, therefore, do not

provide strong evidence in favour of H2. This is confirmed by the two DID estimations. Model 8a estimates for the entire panel dataset whether firms who improved their scores between 2018 and 2019 experienced a significantly different development in EH over time than those whose scores remained constant or declined. Model 8b addresses the same question for the subset of firms that disclosed in both years. Both models estimate a positive but insignificant treatment effect (see Figure 5 and Figure 6). As above, the only alternate specifications which led to an estimated significant effect were those using non-logged values of the response variable and measures of Size, which, again, exhibited heteroskedastic error terms.

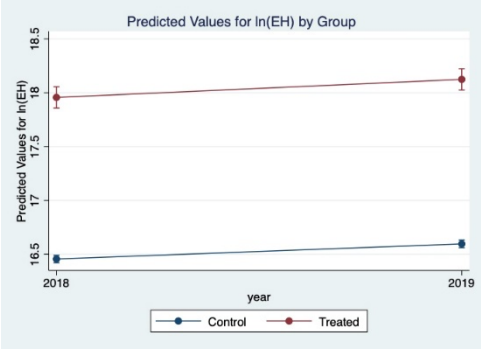

Figure 5 Model 8a - Predicted Values and 95% Confidence Intervals

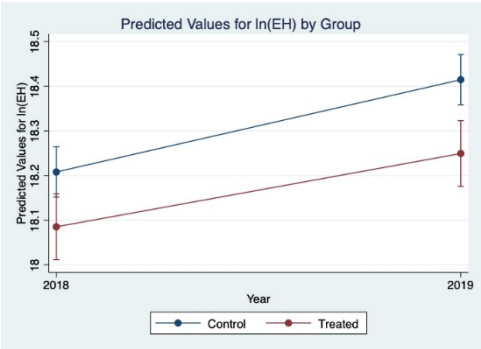

Figure 6 Model 8b - Predicted Values and 95% Confidence Intervals

In sum, whilst single-year cross-sectional analysis estimated that higher levels of environmental stewardship are positively associated with the NWF's investment activity, this conclusion is not supported by the panel models and DID analyses.

5. Discussion

Overall, this analysis does not support either of the two hypotheses outlined above. My results indicate that, in the period considered, the NWF did not significantly shift investments towards companies that participated in voluntary climate disclosures or towards firms that exhibited strong stewardship of climate-related risks. Given the position of the NWF as an investor who is "most likely" to react to climate-related

financial disclosures, this finding falls somewhere on the spectrum between puzzling and concerning. The following section draws on the literature reviewed above to discuss these results, focusing on possible explanations for this lack of significant findings and the implications these findings have for climate-related financial regulation and future research.

5.1. Plausible Explanations

The above analysis provides no evidence that firm-level climate disclosures significantly shape the short-term investment decisions made by the NWF. If such shifts are happening, my analysis suggests that these are either small and uneven across the portfolio or so gradual that they would not emerge in an analysis covering two years. Several plausible reasons could explain these results.

Firstly, one driving factor behind the insignificant results could be that disclosed climate risks are not yet sufficiently tangible or not considered sufficiently reliable to make divestment the dominant investment strategy for the fund. The economic theory underlying the push for disclosures emphasises that they should impact investor behaviour if they can "translate corporate carbon profiles into assessments of risks […] with clear financial implications".[85] However, as Chenet et al. argue, one of the challenges of pricing climate risks is that the immediate risks largely consist of transition risks that arise from the socioeconomic reactions to climate change rather than physical risks that materialise over longer time horizons.[86] Whilst there is a direct trade-off between these two, existing evidence suggests that current corporate climate disclosures, including those conducted via the CDP, predominantly highlight transition risks and rarely consider physical risks.[87] It may, however, be more challenging or even impossible for financial actors to place a price on such risks because they are fraught with high levels

[85] A. Kolk, D. Levy, and J. Pinkse, 'Corporate Responses in an Emerging Climate Regime: The Institutionalization and Commensuration of Carbon Disclosure', *European Accounting Review*, 17/4 (2008), 719–45, 728.
[86] Chenet, Ryan-Collins, and van Lerven, 'Finance, climate-change and radical uncertainty'.
[87] P. Bolstad, S. Frank, E. Gesick, and D. Victor, *Flying Blind: What Do Investors Really Know About Climate Change Risks in the U.S. Equity and Municipal Debt Markets?*, (2020); L. Messling, 'CDP reporting data suggests world's biggest firms are underestimating climate risks | Acclimatise – Building climate resilience', (2019).

of uncertainty.[88] Additionally, assessing the validity of disclosures may be prohibitively difficult for investors, leading these to ignore disclosed information because they do not trust its content. One reason for the fund's lack of reaction to changes in company disclosures may therefore be that the information contained in these reports does not translate into tangible or reliable estimates of financial costs and is therefore side-lined in economic decision-making.

A second plausible explanation for my results could be linked less to the content of disclosures and more to the internal decision-making procedures of the fund. The existing literature points to both structural and behavioural reasons for why disclosures may not lead to the expected shifts of financial assets. On the structural side, various commentators have argued that investor short-termism may hinder the ability of investors to account for climate-related risks.[89] Theoretically, pension funds such as the NWF should be less susceptible to these difficulties, given that their *raison d'être* is to work towards stable returns over the long term. However, Harmes points to the fact that even large pension funds may operate internally on the basis of short-term performance metrics, making it difficult for analysts and portfolio managers to account for climate risks.[90] In addition, the lack of reaction to climate risks by decision-makers in the NWF may be linked to cognitive biases which impact investment decisions.[91] For example, Guyatt and Poulter argue that investor behaviour may be influenced by myopia and cognitive dissonance, which allows individuals to acknowledge the theoretical importance of climate risk but fail to translate this recognition into day-to-day investment practices.[92] Similarly, herd effects may prevent individual analysts from taking decisive action if there is a perceived lack of momentum amongst peers. In short, the lack of significant NWF reaction to CDP disclosures may be linked to an internal

[88] Christophers, 'Climate Change and Financial Instability'; Chenet, Ryan-Collins, and van Lerven, 'Finance, climate-change and radical uncertainty'.
[89] N. Gunningham, 'A Quiet Revolution: Central Banks, Financial Regulators, and Climate Finance', *Sustainability*, 12/22 (2020).
[90] Harmes, 'The Limits of Carbon Disclosure'.
[91] L. F. Ackert and R. Deaves, *Behavioral finance: psychology, decision-making, and markets*, (South-Western Cengage Learning, 2010); Christophers, 'Environmental Beta or How Institutional Investors Think about Climate Change and Fossil Fuel Risk'.
[92] D. Guyatt and J. Poulter, *Institutional Investors and the Behavioural Barriers to Taking Action on Climate Change*, (2019).

failure of the fund to adequately take the disclosed information into account in decision-making procedures.

A third possible explanation is that the fund does not react to the disclosed risks by divesting from companies but by engaging with company leadership. Around the world, several large institutional investors have argued that one avenue to reducing their climate risk exposure is to use their position as shareholders to exert pressure on companies to decarbonise.[93] BlackRock, for example, has publicly stated that its climate strategy rests on such shareholder engagement.[94] Activist shareholder movements to force environmental stewardship have been gaining traction in recent years. A recent example is a campaign of the hedge fund Engine No. 1, which gathered support to oust three members of Exxon Mobil's board as a response to the company's lacking climate action.[95] If the NWF were pursuing a similar strategy, such engagement policies would not be visible through the analytical strategy employed here. However, it should be noted that the existing evidence on shareholder climate activism points to, at best, patchy engagement and limited effectiveness.[96] Despite its vocal statements on climate, BlackRock, for example, has failed to back 75% of climate-relevant shareholder resolutions targeting firms in their portfolios.[97] Even the funds which have demonstrated strong engagement policies for several years are struggling to reduce the vulnerability of their portfolios to climate risks. If the NWF is, therefore, predominantly reacting to disclosures via such engagement, there are reasons to doubt that this would be sufficient to manage their climate risk exposure effectively.

[93] B. D. Stewart, *Business as Usual?: The Limited Influence of Climate Change Disclosure and Fiduciary Duties on the Low-Carbon Investment Practices of Canada's Big 10 Public Pension Funds*, (2020).
[94] BlackRock, *Adapting Portfolios to Climate Change - Implications and Strategies for all Investors*, (2016); BlackRock, 'Investment Stewardship', (2021); L. Fink, 'A Fundamental Reshaping of Finance - Annual Letter to CEOs', (2020).
[95] J. Hiller and S. Herbst-Bayliss, 'Engine No. 1 extends gains with a third seat on Exxon board', (2021); P. Ghosh, 'Activist Shareholder Wins Two Seats On ExxonMobil's Board Amid Battle Over Climate Change', (2021).
[96] 2° Investing Initiative, *Passing the Baton - Climate related investment pledges and their contribution to investor climate pledges*, (2019).
[97] Influence Map, *Asset Managers and Climate Change: How the sector performs on portfolios, engagement and resolutions*, (2021).

5.2. Implications for policy and future research

Absent further investigation, it is impossible to conclude which of these rationales, if any, best explains the lack of significant findings documented in Section 4. Nevertheless, this research has some important implications for financial regulators and opens interesting questions for future research.

Although the drivers behind my findings require further investigation, the observed lack of significant effect carries implications for policymakers interested in tackling climate risks. Given the fund's position as a "most-likely" case, these findings cast doubt on the statement that disclosures, in isolation, allow financial actors to evaluate and price climate risks in a way that impacts investment decisions. It is traditionally argued that disclosures ameliorate the information asymmetries which lead to over-investments in carbon-intensive assets.[98] Following this reasoning, climate-related risk disclosures should suffice to allow financial markets to allocate capital and manage risks. Irrespective of the underlying reasons, my results provide concerning evidence that these hopes may be overstated. This does not mean that regulation should not promote climate-related risk disclosures. On the contrary, CRFDs can still be essential tools for improving our understanding of the business impacts of climate change, raising awareness of climate risk in management boards and strengthening the capacity for other actors to pressure investors and companies to improve environmental stewardship practices.[99] They can also form useful informational tools to allow investors to identify profitable investment opportunities that do not have environmental costs. However, regulators need to be cognizant that disclosures in isolation are unlikely to catalyse the widespread changes in capital allocation required to rapidly realign capital investments with decarbonisation targets. Furthermore, additional mechanisms such as external auditing requirements may be necessary to make disclosures more comprehensive, trusted and impactful.

Future research could expand on my work in several interesting ways. Firstly, the employed analytical strategy has certain limitations which future investigations could address. It would be worthwhile to expand the time horizon of the analysis to assess

[98] Carney and Bloomberg, 'How to make a profit from defeating climate change'.
[99] Gunningham, 'A Quiet Revolution'.

whether there may be more gradual shifts in the NWF's portfolio which were missed here. In addition, adding data from pre-2018 would allow for a more comprehensive pre-treatment comparison of the treatment and control groups in models 4 and 8, thereby allowing for a more substantiated assessment of whether the parallel trends assumption underlying the DID models holds.[100] Alternatively, it may be interesting to focus on either a sectoral or regional subset of the portfolio and build on existing literature on the determinants of CDP participation to develop a propensity score matching (PSM) model.[101] Combining PSM with the DID estimator would strengthen internal validity by reducing the risk that time-invariant omitted variables influence the estimated results.

A second pathway for future research could be to replicate the analysis across different investors. As Harmes emphasises, financial investors are not homogenous.[102] The equity investment landscape is shaped by many actors, including large institutional investors such as pension funds or insurance companies, financial intermediaries, and individual investors. It is not unreasonable to suggest that different subsets of financial actors respond differently to disclosed climate risks. In this study, I have provided an initial step towards an improved understanding of this complex landscape by focusing the analysis on a single, large, investment fund. It would be interesting to assess whether findings would differ if the analysis were repeated on other actors.

Finally, whilst the quantitative approach pursued here has offered a valuable method to assess whether the NWF has reacted to firm-level disclosure decisions at a portfolio level, it cannot answer the equally interesting question of why this is not the case. In Section 5.1, I have drawn on the existing literature to outline possible reasons for my results. Future work could draw on surveys, interviews or other qualitative approaches and focus on improving our understanding of how decision-makers in the NWF and other funds take disclosures into account. Such research would allow us to develop a more well-rounded understanding of the constraints which investors face in

[100] Angrist and Pischke, *Mostly harmless econometrics*.
[101] P. R. Rosenbaum and D. B. Rubin, 'The central role of the propensity score in observational studies for causal effects', *Biometrika*, 70/1 (1983), 41–55.
[102] Harmes, 'The Limits of Carbon Disclosure'.

integrating climate risk into their decision making and, ultimately, aid the design of policies to overcome them.

6. Conclusion

As atmospheric carbon continues to rise, the need to align financial flows with climate objectives is becoming ever more pressing. By continuing to externalise the climatic impact of investments, financial markets not only exacerbate the problem by under-investing in mitigation and adaptation but also continue to accumulate systemic risks. As the Global Financial Crisis demonstrated, such systemic risks can cause sudden and severe financial disruptions with enormous social consequences. It is, therefore, encouraging that financial regulators around the globe are engaging in a debate surrounding their role in the climate response.

In the context of this debate, this paper examines the efficacy of climate-related financial disclosures, one of the essential policy tools under consideration. The existing literature has arrived at competing conclusions regarding the ability of corporate climate disclosures to alter investment flows. This paper approaches this question from a new angle by focusing attention on the behaviour of a single investor, which is a "most-likely" case for responding to climate disclosures: the Norwegian Sovereign Wealth Fund. I constructed a novel dataset that matches the 2018 and 2019 equity portfolios of the NWF with firm-level economic data and CDP disclosure scores. This analysis assessed whether the NWF's portfolio development supports the core policy expectation that investors will value climate risk transparency and risk stewardship. Given the fund's characteristics, I somewhat surprisingly conclude that neither participation in voluntary disclosure schemes nor higher disclosure scores that indicate strong risk stewardship are robustly associated with increased equity investments.

This phenomenon has several plausible explanations. One driving factor may be that investors do not yet regard disclosed climate risks as sufficiently tangible or reliable to provide a strong rationale for divestment. Alternatively, structural constraints and behavioural biases may lead investors to react to disclosures in unexpected ways. Finally,

the fund may respond to climate risk disclosures by engaging with company leadership and exerting pressures to improve environmental performance rather than divesting. Regardless of which hypothesis holds, my analysis demonstrates that whilst disclosures remain an essential policy tool, they are not a panacea. Both policymakers and researchers need to remain aware that financial markets are constituted by a heterogeneous group of investors with different objectives, constraints, and biases. It cannot be assumed that markets will react to disclosed information on novel risks in a premeditated, rational, and homogenous manner.

This working paper has two core conclusions. Firstly, we require an improved understanding of the barriers and constraints which shape how financial actors respond to climate risks. Secondly, for policy to be successful in catalysing a transition to "green finance", the policy debate needs to remain broad and creative, allowing for combinations of different and targeted policy tools rather than the current focus on a one-size-fits-all solution.

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