The Effect of Mandatory Carbon Disclosure Regulation on Institutional Investment Behaviour and Financial Decision-Making

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Copyright Statement

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Thesis Abstract

This thesis examines the impact of mandatory carbon disclosure on institutional investment behaviour and corporate financial policy, using the U.K.'s 2013 Strategic Report and Directors' Report Regulations as a quasi-natural experiment. Employing a difference-in-differences (DiD) approach to address endogeneity concerns, it draws primarily on agency theory, complemented by signalling and stakeholder theories, to provide causal evidence on how climate-related transparency reshapes investor capital allocation, dividend policy, and liquidity management.

The first empirical study examines institutional investor heterogeneity and finds that firms reducing emissions after mandatory disclosure attract greater ownership from long-term, independent, and climate-conscious investors, as well as from investors based in countries with strong environmental norms. In contrast, short-term, grey, non-climate-conscious investors, and those from countries with weaker environmental norms, show little or no response. These patterns suggest that enhanced transparency reduces information asymmetry and aligns managerial incentives with sustainability-oriented stakeholders.

The second study analyses dividend policy, finding that disclosure requirements lead to an increase in payouts, particularly in firms with a high level of institutional ownership, specifically long-term institutional investors and low carbon emissions. This aligns with agency theory predictions and highlights dividends' role as a signalling mechanism of financial stability and responsible management.

The third study explores abnormal cash holdings, showing significant reductions in excess liquidity post-disclosure, especially among high-emission firms with strong institutional oversight, consistent with improved governance discipline. Overall, the findings demonstrate that mandatory carbon disclosure not only advances environmental accountability but also

drives tangible changes in corporate governance and financial decision-making, reinforcing the role of regulatory transparency as a catalyst for sustainable and shareholder-aligned business practices.

Table of contents

Contents

List of Tables

List of Figures

Chapter 3 Carbon Intensity and Investor Heterogeneity

Chapter 4 Mandatory Carbon Disclosure and Dividend Policy

Chapter 5 Mandatory Carbon Disclosure and Abnormal Cash Holdings

List of Abbreviations

AIM	Alternative Investment Market
BM	Book-to-Market ratio
CDP	Carbon Disclosure Project
CEPII	Centre d'Études Prospectives et d'Informations Internationales
CPF	Carbon price floor CPF
CSR	Corporate Social Responsibility
DiD	difference-in-differences
DiDiD	difference-in-difference-in-differences
EEA	The European Economic Area
E&S	Environmental and Social
EPI	Environmental Performance Index
ESG	Environmental, Social, and Governance
EU	European
EU ETS	The European Union Emissions Trading System
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IO	Institutional Ownership
LSE	London Stock Exchange
MB	Market-to-book value ratio
PPE	Property, plant, and equipment
PRI	Principles of Responsible Investment
PSM	Propensity score matching
R&D	Research and Development
ROA	Return on Assets
ROE	Return on Equity
tCO_2eq	tonnes of carbon dioxide equivalent
U.K.	United Kingdom
USA	United States of America
USD	United States Dollar

Chapter 1 Introduction

1.1 Background and motivation

Climate change is one of the most urgent social challenges today, and growing awareness is rightly focused on firms whose carbon emissions are among the primary drivers of the crisis. In response to growing environmental challenges, governments worldwide have strengthened environmental regulations and increasingly adopted policies requiring firms to disclose standardised and verifiable information on greenhouse gas (GHG) emissions. These mandatory disclosure regimes aim not only to enhance transparency but also to promote accountability, improve the comparability of environmental performance across firms, and ultimately incentivise emissions reduction. Historically, voluntary reporting frameworks have suffered from issues of selective disclosure, non-standardised metrics, and poor comparability between firms and industries. (Christensen et al., 2021; Grewal et al., 2019; Jouvenot & Krueger, 2019). These shortcomings have prompted jurisdictions such as the United Kingdom, with its 2013 mandatory carbon disclosure regulation, the European Union through the Corporate Sustainability Reporting Directive (CSRD), and increasingly the United States, to introduce legislation mandating standardised carbon reporting. By making reliable emissions data publicly available, these policies aim to reduce information asymmetry, enhance market efficiency through the more accurate pricing of environmental risks and opportunities, and strengthen market discipline (Bui et al., 2020; Krueger et al., 2020). Nevertheless, the broader economic consequences of such regulatory mandates remain the subject of ongoing debate.

Emerging finance literature provides both theoretical and empirical evidence on the effects of carbon emissions disclosure.[1] Examining the impact of corporate carbon disclosure

[1] See, for example, Amin et al., 2024; Downar et al., 2021; Bolton et al., 2024; Bolton & Kacperczyk, 2021; Ilhan et al., 2021; Jouvenot & Krueger, 2019, 2019; Kacperczyk & Peydró, 2022; Krueger et al., 2020; Matsumura et al., 2014; Riordan & Nerlinger, 2022; Trinks et al., 2022.

is important because it can help mitigate climate change, foster a resilient and sustainable economy, and enhance accountability, risk management, and investment decision-making. Empirical research on mandatory environmental disclosure policies has examined a range of firm-level outcomes, including emissions reductions (e.g. Downar et al., 2021; Jouvenot & Krueger, 2019), board or committee structures (Boamah, 2022), risk and cost of capital (Bolton & Kacperczyk, 2021a; Bui et al., 2020; Ilhan et al., 2021), firm valuation (Krueger, 2015), stock returns (Bolton & Kacperczyk, 2021b), and institutional ownership patterns (Agarwal, 2009; Ilhan et al., 2019; Krueger et al., 2020; Starks et al., 2017). However, much of this literature either concentrates on empirical analyses of firm outcomes or relies on surveys and questionnaires to capture institutional investors' preferences for low-carbon or high-disclosure firms (Ilhan et al., 2019; Krueger et al., 2020), leaving open questions on the empirical study of how mandatory disclosure and carbon emissions shape institutional investors' allocation and their managerial decision-making processes (e.g., dividend policy and cash holdings). In doing so, a central debate of this thesis persists over both the motivations for institutional investors to incorporate such considerations into their portfolio decisions and how firms adjust their financial decision-making following the regulation.

This thesis presents three empirical chapters designed to address these gaps. The first empirical chapter (Chapter 3) examines how heterogeneous types of institutional investors with varying investment horizons, monitoring intensity, and sustainability orientations adjust their capital allocation towards reduced-emission firms after the disclosure regulation. The second empirical chapter (Chapter 4) examines how firms modify their dividend payout policies in response to increased transparency and investor scrutiny after introducing the mandatory carbon disclosure regulation. The third empirical chapter (Chapter 5) analyses the effect of mandatory disclosure on corporate abnormal cash holdings. To better identify the causal effect of corporate carbon-emissions reductions on heterogeneous institutional investor behaviour, I exploit the exogenous shock that can reduce the carbon emissions level introduced by the U.K. mandatory carbon-disclosure regulation, following Jouvenot and Krueger (2019).

The first empirical study in this thesis (Chapter 3) examines whether firms that lower carbon emissions attract investment from heterogeneous institutional investors in distinct ways following the introduction of a unique mandatory carbon disclosure regulation, using a quasi-natural experiment by employing the U.K. mandatory carbon disclosure [2] introduced in September 2013 as an exogenous shock[3]. In this thesis, "heterogeneous institutional investors" are defined along four categories: investment horizon (long-term versus short-term), monitoring role (independent versus grey), responsible investment orientation (Principles for Responsible Investment (PRI)[4] signatories versus non-signatories), and home-country norms of institutional investors (climate-conscious versus less climate-conscious country domicile).

Institutional investors play a central role within this evolving regulatory environment. As the primary shareholders in the majority of publicly listed firms, they hold substantial influence over the allocation of capital and, consequently, over how financial markets respond to environmental information. Survey evidence suggests that a substantial proportion of institutional investors perceive climate risks, particularly regulatory risks, as financially material and have already begun integrating these considerations into investment decisions (Ilhan et al., 2019; Krueger et al., 2020). Using global data, Bolton & Kacperczyk (2021a)

[2] The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013 (the Act) mandates that all firms listed on the Main Market of the London Stock Exchange (LSE) disclose their greenhouse gas (GHG) emissions in a standardised format within their annual reports.

[3] In Chapter 2 of this thesis, I provide an overview of the Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, including which firms are subject to the Act, the specific information they are required to report, the details of the carbon emission scopes as defined by the GHG Protocol, the reporting location for GHG emissions, and the features that make the U.K.'s mandated carbon disclosure framework unique.

[4] PRI (Principles for Responsible Investment) is a UN-supported global investor initiative launched in 2006 by the Finance Initiative and the UN Global Compact that sets out six voluntary principles to help asset owners, investment, and service providers integrate environmental, social, and governance (ESG) factors into investment and ownership decisions; organisations that sign commit to apply the principles and report on their progress each year.

document that institutional investors are significantly underweight in high-carbon-emissions firms. Similarly, Jouvenot & Krueger (2019) indicate that institutional investors reallocating capital toward lower-emitting firms once standardised data made emissions salient and comparable. However, aggregate measures of institutional ownership hide substantial differences in investors' objectives, constraints, and behavioural responses.

Recent evidence regarding institutional allocation suggests that aggregate measures of institutional ownership can mask substantial heterogeneity in investors' environmental preferences. For example, et al. (2022) document that mandatory CSR disclosure affects the portfolio allocation decisions of different types of institutional investors in distinct ways, indicating that some respond strategically to regulatory transparency while others remain largely indifferent. Similarly, Starks et al. (2017) find that long-horizon institutional investors tend to overweight high-ESG firms and display greater patience toward these holdings, selling significantly less following negative earnings surprises or poor returns compared to their other positions. Atta-Darkua et al. (2023) argue that climate-conscious institutions decarbonise primarily by re-weighting their portfolios toward firms that already have lower emissions, especially when the investor is based in a jurisdiction with carbon-pricing. These patterns suggest that mandatory carbon disclosure may elicit markedly different portfolio adjustments across investor types, reflecting divergent strategic, governance, and normative priorities.

Theoretical mechanisms plausibly connect firms' carbon-emissions reductions with heterogeneity in institutional investors' allocation. Consistent with agency and signalling theories, mandatory carbon reporting increases the transparency, reliability, and cross-firm comparability of emissions data, which in turn mitigates information asymmetries and supports the valuation of transition risk and the appraisal of governance quality. Long-term horizon institutions therefore have stronger incentives than short-horizon traders to reallocate toward firms with verified emissions reduction because the benefits, including lower downside risk, improved governance signals, and reduced carbon risk premium, accrue over long investment horizons (Bolton & Kacperczyk, 2021b; Chen et al., 2018; Dhaliwal et al., 2011; Hoepner et al., 2024; Ioannou & Serafeim, 2017). Identity also matters because independent institutions rely more on public information and have fewer business ties to portfolio firms. Hence, they value the reputational and monitoring benefits of transparent decarbonization more than grey investors (e.g., banks/insurers) who may have private information channels or conflicts of interest (Ferreira & Matos, 2008; Dyck et al., 2019). In addition, active ownership reinforces these patterns because engagement on environmental issues is associated with lower downside risk, which gives long-horizon and independent investors further reason to overweight firms with credible emissions reductions.

Institutional investors' responsible commitments and the social norms of their home countries also influence their investment allocations once disclosure quality improves. Investors that are signatories to the Principles for Responsible Investment (PRI), which emphasise ESG integration, active ownership, and transparency in Principles 1 to 3, are particularly likely to adjust their portfolios in response to improved disclosure.[5]. They are better able to use comparable carbon data in screening and risk models, which leads them to tilt more toward firms with verified emissions reductions (Gibson Brandon et al., 2022; Ioannou & Serafeim, 2017). Social norms act as preference shifters in which investors from countries with strong pro-environment norms and supportive institutions are more likely to treat emissions reductions as both financially material and normatively desirable, consistent with evidence that norms guide portfolio choices and that investors underweight firms at odds with prevailing values (Hong & Kacperczyk, 2009). Cross-country studies show that such investors transmit

[5] PRI Principles #1–#3 include:
#1 We will incorporate environmental, social and governance (ESG) issues into investment analysis and decision-making processes.
#2 We will be active owners and incorporate ESG issues into our ownership policies and practices.
#3 We will seek appropriate disclosure on ESG issues by the entities in which we invest.

home-country expectations to portfolio firms and are associated with stronger environmental performance, while surveys document that many institutions now view climate risk as central to investment decisions (Liang & Renneboog, 2017; Dyck et al., 2019; Krueger et al., 2020). Together, these mechanisms explain why long-horizon and independent investors, PRI signatories, and investors from high-norm countries are most likely to increase holdings of firms that demonstrably reduce carbon emissions under mandatory disclosure.

In Chapters 4 and 5, I examine the effects of mandatory carbon disclosure on firm financial decision-making, including dividend policy and abnormal cash holdings. While much of the literature on mandatory environmental disclosure has concentrated on market valuation effects, ESG ratings, or aggregate changes in institutional ownership, the influence of such regulation on corporate financial policies, particularly dividend payouts and abnormal cash holdings[6] remains underexplored. These policies are fundamental to understanding managerial decision-making, as they directly reflect how firms allocate free cash flows between shareholders, precautionary reserves, and reinvestment opportunities.

Theoretically, mandatory carbon disclosure may influence dividend policy through several mechanisms grounded in agency theory, signalling theory, and compliance cost considerations. Enhanced transparency reduces information asymmetry between managers and shareholders, thereby increasing the effectiveness of institutional investor monitoring (Christensen et al., 2018; Hail et al., 2014). Under agency theory, such monitoring pressure can constrain managerial discretion over free cash flows, leading to higher and more stable dividend distributions to limit funds available for potential overinvestment (Fonseka & Richardson, 2023). From a signalling perspective, firms may use higher dividends to convey financial stability and commitment to shareholder value in a post-regulation environment where

[6] The concept of "abnormal cash holdings" in this thesis, defined as the portion of a firm's cash balance that exceeds the level predicted by firm-specific determinants such as size, leverage, profitability, and industry norms (Opler et al., 1999). Excess liquidity can be value-reducing if it facilitates managerial empire-building or inefficient investments, as suggested by Jensen's (1986) free cash flow hypothesis.

sustainability credentials are integrated into market valuations (Baker & Wurgler, 2004; Benlemlih et al., 2023). Furthermore, firms with lower carbon emissions may benefit from reduced expected compliance costs, leaving greater residual resources available for shareholder payouts (Ioannou & Serafeim, 2017).

Similarly, mandatory carbon disclosure can reduce abnormal cash holdings through agency theory, signalling, and stakeholder pressure channels. Publicly disclosed, standardised GHG data enhance the monitoring capacity of institutional investors, especially those with long investment horizons and active engagement strategies, making it more difficult for managers to justify holding excess liquidity without a clear strategic purpose (Dittmar & Mahrt-Smith, 2007; Harford et al., 2008). This increased scrutiny raises the reputational and governance costs of inefficient cash retention, encouraging firms to align liquidity levels more closely with operational needs. From a signalling standpoint, reducing excess cash can demonstrate governance quality and operational discipline, particularly in high-emission firms seeking to counteract reputational risks (Dhaliwal et al., 2012). Moreover, stakeholder pressure, particularly from environmentally focused investors, may encourage firms to use excess cash for debt reduction, shareholder payouts, or sustainability initiatives rather than holding it as precautionary reserves.

In conclusion, mandatory carbon disclosure has introduced a new paradigm in corporate behaviour and capital market reactions. A growing literature posits that those regulatory disclosures, especially those concerning environmental externalities such as GHG emissions, serve to (1) reduce information asymmetry, (2) improve transparency, and (3) strengthen market discipline (Dhaliwal et al., 2012; Krueger et al., 2020). Such regulations create exogenous variation in firm behaviour, offering a valuable opportunity to understand environmental governance's economic implications. In light of these discussions, this thesis aims to provide a deeper understanding of how mandatory carbon disclosure shapes both investor behaviour and corporate financial decisions. Building on the theoretical mechanisms and prior empirical evidence outlined above, the next section formulates the research questions and hypotheses guiding the three empirical chapters. Section 1.2 summarises these questions alongside the main findings, highlighting how each chapter contributes to the overall objective of examining the financial and behavioural consequences of the U.K. 2013 mandatory carbon disclosure regulation.

1.2 Research questions, related hypotheses and findings

1.2.1 Does carbon intensity attract more investment from institutional ownership

In Chapter 3, I examine whether firm-level carbon intensity attracts more investment from institutional ownership and whether heterogeneous institutional investors allocate their investments differently in firms actively reducing their carbon emissions. Motivated by the growing focus of investors on environmental, social, and governance (ESG) metrics (Bolton et al., 2021; Dyck et al., 2019) and the increasing materialisation of climate risks in investment strategies (Krueger et al., 2020). This chapter employs the introduction of mandatory carbon disclosure regulations in the United Kingdom as a natural experiment to explore these questions. Specifically, I examine whether firms complying with mandatory carbon disclosure regulations and reducing their carbon emissions attract higher levels of institutional ownership and whether institutional investors with varying investment objectives respond differentially to such firms. This finding aligns with prior work indicating that institutional investors are increasingly sensitive to climate risks and environmental performance (Bolton et al., 2021; Cohen et al., 2023b; Dyck et al., 2019)

Drawing on the literature that emphasises the financial and non-financial motivations behind institutional investors' consideration of climate risks (Krueger et al., 2020; Starks et al., 2017). I first explore the relationship between the U.K. mandatory carbon disclosure regulations and institutional ownership. The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013 in the U.K. introduced a unique mandate requiring publicly listed firms to disclose their greenhouse gas (GHG) emissions in a standardised format. Further details about this regulation are provided in Chapter 2. This regulation serves as an exogenous shock, prompting firms to reduce their GHG emissions and emission intensity significantly, as suggested by Jouvenot and Krueger (2019). Drawing on the literature of ESG and CSR investment (i.e. Marshall et al., 2022; Starks et al., 2017), I hypothesise that firms complying with these mandatory disclosure regulations attract a greater level of institutional investors.

Next, I dig deeper into the heterogeneity of institutional investors and their preferences for firms with improved carbon practices, including investment horizon, monitoring role, social norm countries' domicile, and responsible institutional investors. The literature suggests that institutional investors vary significantly in their investment objectives, horizons, and norms regarding environmental performance (Gibson Brandon et al., 2022; Starks et al., 2017). For instance, long-term investors are more likely to prioritise ESG issues due to their alignment with sustainable financial performance. In contrast, responsible institutional investors, such as Principles for Responsible Investment (PRI) signatories, often emphasise active monitoring and responsible investing (Marshall et al., 2022). I conjecture that these distinct investor characteristics influence their investment decisions differently when evaluating firms' carbon emissions performance.

In line with the above hypotheses, I find compelling evidence supporting the carbon emissions reduction attraction hypothesis. In the post-disclosure regulation period, institutional investors significantly increased their stakes in firms complying with the mandatory carbon disclosure requirements. Economically, the change in institutional ownership of treated firms is an average increase of 10.01% in total carbon emissions intensity. Furthermore, the results support the institutional investor heterogeneity hypothesis, indicating that investors with longer investment horizons, such as pension funds, are more likely to increase their investments in compliant firms compared to those with shorter horizons, such as hedge funds. Independent institutional investors and climate-conscious investors, including PRI signatories and investors from countries with strong social norms, also show a preference for investing in firms that have reduced their carbon emissions.

1.2.2 Does mandatory carbon disclosure matter for dividend payment

In Chapter 4, I examine whether mandatory carbon disclosure regulation affects corporate dividend policy. In particular, this chapter examines the impact of the *U.K.'s Strategic Report and Directors' Report Regulations 2013*, which mandate firms to disclose standardised carbon emissions data, on corporate dividend payout behaviour. This inquiry is situated within the broader context of the growing global emphasis on environmental transparency and the movement toward compulsory environmental disclosures (Downar et al., 2021; Krueger et al., 2020). The analysis seeks to determine whether such regulatory initiatives affect firms' tangible financial decisions, specifically their approaches to dividend distribution.

Theoretically, the expected direction of the effect is ambiguous. On the one hand, mandatory carbon disclosure could constrain firms financially. The increased visibility and political scrutiny from such regulations might force firms to redirect cash flows toward sustainability investments, increasing the incentive to retain earnings and potentially reducing dividend payouts (Chen et al., 2024a; Ioannou & Serafeim, 2017). This perspective is consistent with the financing-based view of dividends, whereby internal capital is preserved to meet anticipated regulatory or reputational obligations (Gibbons, 2020). On the other hand, improved transparency and lower information asymmetry may strengthen investor oversight and reduce agency problems, leading to greater pressure for firms to maintain or even increase dividend payouts (Baker & Wurgler, 2004; Nagar & Schoenfeld, 2021). Enhanced disclosure can serve as a commitment mechanism to shareholder value maximisation, especially in the presence of long-term institutional investors who are more attentive to ESG practices and governance quality (Fonseka & Richardson, 2023a; Grewal et al., 2019).

In light of these competing arguments, the core research question posed in Chapter 4 of this thesis is whether mandatory carbon disclosure impacts firms' dividend policies and, if so, through which channels and under what contextual factors this effect is most significant. To empirically test this, I exploit the quasi-natural experiment provided by the U.K.'s 2013 disclosure mandate and use a difference-in-differences (DID) approach comparing dividend policies of U.K.-listed firms (treatment group) with those of comparable European firms not subject to the regulation (control group). Consistent with the investor-monitoring and agency cost reduction hypothesis, I find that mandatory carbon disclosure is associated with a statistically and economically significant increase in firms' dividend payout ratios. Specifically, treated firms experience an average dividend increase of 8.69% following the regulation. These results are robust to alternative specifications, including various dividend measures, placebo tests using fake treatment periods, and random assignment checks. No significant pre-trends are detected, validating the DiD framework and the parallel trends assumption.

To explore the heterogeneity of the effect, I further examine the moderating roles of institutional ownership and carbon emissions levels. The dividend increase is particularly strong among firms with high institutional ownership and long-term institutional investors, suggesting that institutional investors reinforce transparency-based governance and restrict managerial use of excess cash. Moreover, firms with lower carbon emissions respond more strongly to their dividend payouts, likely because they face fewer compliance costs and can better benefit from the positive signalling effects of disclosure.

While this chapter demonstrates the impact of disclosure regulation on dividend policy, research directly linking mandatory carbon disclosure to cash management, particularly abnormal cash holdings, remains limited. Dividend policy primarily reflects firms' explicit commitments to shareholders, serving as a signal of managerial confidence and a mechanism to reduce agency costs by constraining free cash flow available for discretionary use (Jensen, 1986). In contrast, abnormal cash holdings capture managerial discretion in liquidity management, shaped by transaction motives, agency conflicts, and risk aversion (Bates et al., 2009; Opler et al., 1999). Therefore, examining abnormal cash holdings separately provides valuable insights into managerial behaviour and internal financial policies following regulatory changes, beyond what dividend decisions can reveal. While dividends may signal transparency and reduce agency concerns, excess cash balances may be viewed with greater scrutiny for potential misuse (Pinkowitz et al., 2012), particularly under enhanced disclosure requirements. Al-Najjar & Belghitar (2011) find that, after accounting for simultaneity, dividend payments do not significantly affect cash holdings, nor do cash holdings significantly influence dividend policy. Prior studies also show that cash holdings and dividends respond differently to governance or regulatory changes due to differing managerial incentives and financial constraints (Harford et al., 2008; Pinkowitz et al., 2012). For instance, firms facing higher transparency requirements may reduce abnormal cash reserves to avoid scrutiny over inefficient capital allocation and agency costs, aligning managerial interests more closely with shareholder value. Alternatively, firms may increase liquidity buffers in response to greater operational or regulatory uncertainty introduced by mandatory disclosure, reflecting precautionary motives (Duchin, 2010). By isolating the effect of mandatory carbon disclosure on abnormal cash holdings, the next chapter extends this analysis beyond shareholder distributions to explore internal capital allocation and managerial discipline in a post-disclosure regulatory environment.

1.2.3 Does mandatory carbon disclosure matter for abnormal cash holdings

In Chapter 5, I examine whether mandatory carbon disclosure regulations influence corporate decisions regarding abnormal cash holdings. Specifically, I explore the impact of the U.K.'s mandatory carbon disclosure regulation introduced in 2013, examining how firms adjust their liquidity management, particularly abnormal levels of cash holdings, in response to increased environmental transparency requirements. Motivated by recent global attention toward corporate carbon emissions and the regulatory emphasis on climate transparency (Amin et al., 2024; Li et al., 2022), I exploit the natural experiment provided by implementing the U.K.'s Strategic Report and Directors' Report Regulations 2013. This setting enables a robust investigation into how mandated carbon emissions disclosures affect firms' cash management practices, with a particular focus on abnormal cash holdings, including both excess cash and insufficient cash levels.

Prior research indicates that firms maintain cash reserves to buffer against liquidity shocks (precautionary motive) or alternatively accumulate excess cash due to managerial entrenchment and agency conflicts (agency motive). Considering these opposing theoretical frameworks, this chapter examines the extent to which mandatory carbon disclosure regulations impact abnormal cash holdings and through which mechanisms they influence corporate liquidity management. From a precautionary perspective, mandatory carbon disclosures may increase uncertainty for firms, especially those with high carbon emissions, prompting firms to hold greater cash reserves to hedge against potential compliance costs and environmental risks (Azar et al., 2021; Bolton & Kacperczyk, 2021b). Conversely, from an agency theory perspective, enhanced transparency and increased stakeholder scrutiny due to mandatory disclosures may lead firms, particularly those with previously high levels of excess cash, to reduce cash holdings to signal efficient financial governance and mitigate reputational risks associated with hoarding cash (Chithambo et al., 2020; Harford et al., 2008). To empirically address these competing predictions, I employ a difference-in-differences (DiD) approach using the U.K.'s mandatory carbon disclosure requirement in 2013, providing a quasi-natural experimental setting. Specifically, I compare the abnormal cash holdings of U.K.-listed firms (treatment group) to those of firms listed in other European countries unaffected by the regulation (control group). Abnormal cash holdings are calculated as deviations from firms' empirically estimated optimal cash levels, following the widely used approach established by Opler et al. (1999).

Consistent with the agency theory hypothesis emphasising improved governance through enhanced transparency, the findings demonstrate a statistically significant reduction in abnormal cash holdings by approximately 4.66% among firms subject to mandatory carbon disclosure regulations. More detailed analyses reveal that this effect is primarily driven by a substantial reduction in excess cash holdings, which decline by about 20.83% post-regulation. In contrast, absolutely insufficient cash holdings exhibit a moderate increase. These results suggest that mandatory carbon disclosure effectively constrains managerial discretion over cash resources, prompting firms to optimise their liquidity management.

Further analysis of heterogeneity shows that the reduction in abnormal cash holdings is more pronounced among firms with higher institutional ownership, particularly those held by long-term investors, and firms with higher carbon emissions levels. This finding supports the view that firms subject to greater stakeholder scrutiny are more likely to adjust their cash management practices to demonstrate sound financial governance and compliance with environmental expectations.

1.3 Thesis contributions

The main contributions of this thesis can be outlined as follows. Chapter 3 adds to the expanding research on how firm-level carbon emissions affect financial markets by focusing on differences among investors and how they adjust their portfolios in response to mandatory carbon disclosure rules. Prior studies have shown that investors are increasingly attentive to non-financial considerations such as environmental and social (E&S) factors, with particular emphasis on climate-related risks (see, for instance, Dyck et al., 2019; Krueger et al., 2020). This chapter extends that discussion by showing that firms which improve their carbon performance in line with regulatory requirements tend to attract higher levels of institutional investment. Specifically, using a quasi-natural experimental approach, I extend the understanding of how firm-level carbon emissions influence institutional investor fund flows and highlight the economic significance of environmental issues in shaping investment decisions.

This chapter also shows that institutional investors respond differently to mandatory carbon disclosure depending on their characteristics. Investors with different investment horizons and styles, as well as those with stronger climate-related preferences, adjust their investment behaviour in distinct ways. While earlier research has examined how institutional investors affect firms' carbon emissions and environmental practices (Chen et al., 2020; Dyck et al., 2019), this study is, to my knowledge, the first to apply the U.K. carbon disclosure regulation as a natural experiment to identify the causal impact of heterogeneous institutional ownership on firms' carbon-related practices. This approach provides new insights into how regulatory changes influence investor behaviour and the environmental strategies of firms within global financial markets.

Chapter 4 significantly expands the literature on mandatory environmental disclosures by examining their influence on corporate dividend policy. While prior research has largely concentrated on general financial and operational impacts of mandatory ESG disclosure (Baboukardos, 2017; Krueger et al., 2020), this study uniquely identifies dividend payout decisions as a consequential financial outcome of such regulations. Employing the U.K.'s Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, I provide robust evidence that mandatory carbon disclosure leads to a substantial increase in dividend payout ratios. Furthermore, the findings identify institutional ownership and firm-specific emission levels as critical moderating factors. By offering this nuanced perspective, the study contributes not only to the broader ESG literature but also to the specialised domain of dividend policy, providing policymakers and investors with clearer insights into the broader financial ramifications of enhanced environmental transparency.

Chapter 5 makes distinctive contributions to the literature on corporate cash management and the financial implications of climate-related disclosures. While prior studies primarily focus on general environmental performance or voluntary ESG disclosures in relation to corporate liquidity policies (Amin et al., 2024; Tan et al., 2021), this thesis provides novel empirical evidence regarding how mandatory carbon disclosures specifically affect abnormal cash holdings. Employing a quasi-natural experimental design centred around the introduction of mandatory carbon disclosure in the U.K., this chapter demonstrates a statistically significant reduction in firms' abnormal cash holdings, particularly excess cash reserves. Additionally, the findings underscore that the magnitude of this reduction is notably stronger among firms with higher institutional ownership, specifically long-term institutional investors and greater emission intensity, highlighting how increased transparency and regulatory scrutiny shape corporate financial discipline. This research offers critical insights for policymakers and corporate governance scholars, illustrating how targeted disclosure mandates can mitigate agency conflicts and optimise cash resource allocations.

In conclusion, this thesis advances the interdisciplinary literature bridging corporate finance, environmental economics, and institutional investment. It provides comprehensive empirical evidence illustrating how mandatory carbon disclosure regulations not only reshape investor decisions and behaviours but also significantly influence corporate financial strategies, including dividend policy and liquidity management. By highlighting the nuanced interactions between regulatory environments, corporate behaviours, and institutional investor preferences, this thesis enhances the understanding of the economic implications of environmental transparency regulations. Ultimately, these contributions emphasise the importance of considering environmental factors in corporate financial decision-making and regulatory policy design, underscoring the critical role of mandatory environmental disclosure in fostering financially and environmentally sustainable business practices.

1.4 Overall conclusions

This thesis examines how mandatory carbon disclosure regulations influence firm financial behaviour and institutional investor responses across different contexts. The collective evidence from the three empirical studies offers key insights into how regulatory environmental disclosure shapes firms' financial decision-making and market dynamics.

Firstly, the findings from the investigation of carbon intensity and investor heterogeneity illustrate that institutional investors significantly alter their investment allocations following mandated carbon disclosures. Investors demonstrate increased investment interest in firms actively reducing their carbon emissions. Importantly, however, this response varies considerably based on investor characteristics and objectives. Climate-conscious investors, long-term investors, and independent institutional investors exhibit stronger preferences for firms showing substantial carbon emission reductions. These results highlight that institutional investors are not uniformly attracted to improved environmental performance; rather, their response is intricately tied to their investment strategies, horizons, and governance roles.

Secondly, examining dividend policy under mandatory carbon disclosure reveals that firms subject to carbon disclosure regulations significantly increase their dividend payouts. This increase is particularly pronounced among firms with lower carbon emissions and higher institutional ownership, suggesting that mandatory disclosures alleviate information asymmetry and reduce agency conflicts, thereby influencing firms to adopt more shareholder-friendly dividend policies. These findings underscore that environmental disclosure mandates function beyond mere regulatory compliance, actively shaping financial policies that enhance firm credibility and investor relations.

Lastly, the analysis of abnormal cash holdings under mandatory carbon disclosure indicates a notable decline in firms' abnormal cash reserves, especially among firms with higher emissions and greater institutional ownership. This result suggests that mandatory carbon disclosures enhance the quality of corporate governance and transparency, effectively mitigating managerial discretion and agency costs associated with excessive cash holdings. Consequently, carbon disclosures help investors and other stakeholders monitor corporate financial management more effectively, fostering more disciplined cash management behaviours.

Collectively, this thesis emphasises that mandatory carbon disclosure is a multifaceted instrument with substantial financial and strategic implications. It significantly impacts institutional investment decisions, corporate dividend strategies, and liquidity management. Thus, this thesis contributes to a deeper understanding of how environmental transparency regulations influence corporate governance and financial strategies, offering critical insights for investors, corporate managers, and policymakers. The three chapters together demonstrate a coherent narrative: mandatory carbon disclosure acts as a catalyst for firms to reduce carbon emissions, which in turn enhances institutional investor confidence and increases ownership. This increase in ownership leads to improved internal governance, as institutional investors exert pressure on firms to adopt more transparent, shareholder-aligned financial policies reflected in higher dividend payouts and reduced abnormal cash holdings.

Economically, the findings contribute to my understanding of how climate-related financial disclosures translate into tangible changes in capital allocation and corporate behaviour, offering valuable insights for policymakers, regulators, and asset managers. From an academic perspective, this thesis strengthens the linkage between environmental regulation and financial outcomes, integrating insights from environmental economics, corporate finance, and institutional theory. It answers emerging calls in the literature to move beyond surface-level ESG ratings and examine real corporate responses to environmental regulation.

1.5 Thesis structure

The remainder of this thesis is organised as follows. **Chapter 2** provides an overview of the U.K. Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, which serve as the regulatory shock underpinning all three empirical chapters. **Chapter 3** explores how firms' carbon intensity influences the investment decisions of institutional investors. **Chapter 4** analyses whether mandatory carbon disclosure has an impact on dividend policy. **Chapter 5** considers the relationship between mandatory carbon disclosure and firms' abnormal cash holdings. Finally, **Chapter 6** brings this thesis to a close by summarising the main findings, highlighting its limitations, and suggesting directions for future research.

Chapter 2: An overview of The Companies Act 2006 (Strategic Report and Directors’ Report) Regulations 2013.

2.1 The introduction of the U.K. mandatory GHG emissions disclosure

The introduction of mandatory carbon reporting in the U.K. marked an important change in corporate regulation, designed to strengthen transparency and accountability for environmental impacts. Brought in through the Companies Act 2006 (Strategic Report and Directors’ Report) Regulations 2013, this rule requires certain publicly listed firms to provide consistent disclosure of their GHG emissions. The regulation applied to financial years ending on or after 30 September 2013 and represents a key move towards embedding environmental responsibility within corporate governance and financial reporting practices.

Specifically, these amendments require affected firms to incorporate detailed GHG emissions data within their annual strategic and directors' reports. The strategic report, newly mandated by this regulation, provides a comprehensive overview of the company's performance, strategy, and principal risks, including environmental impacts. Concurrently, revisions to the directors' report require specific disclosures of both absolute GHG emissions and emissions intensities, alongside clearly articulated methodologies employed in their calculation. Including these disclosures in companies’ annual reports helps ensure that firms take greater responsibility for their actions, facilitates informed decision-making among investors and stakeholders, and ultimately encourages reductions in corporate carbon footprints (Jouvenot & Krueger, 2019; Krueger et al., 2020).

In this thesis, this regulation serves as an external shock and a key identifier within frameworks for firm carbon performance and emission reduction, as indicated by Jouvenot and Krueger (2019), providing a robust basis for empirical analyses of corporate behaviour and performance in response to mandated environmental transparency. As such, this thesis leverages the implementation of these regulations as a primary source of identification, examining their implications for firm practices, investor behaviour, and financial implications within the U.K. listed firms. This chapter offers background context on the Act as follows.

2.2 Firms concerned by the Act

The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013 came into force on 30 September 2013, introducing the first mandatory corporate carbon disclosure requirement in the United Kingdom. The regulation applies to all quoted companies incorporated in the U.K. and publicly listed on recognised stock exchanges. According to Section 385(2) of the Act, a quoted company is defined as one whose equity shares are listed on the Main Market of the London Stock Exchange (LSE), on any exchange within the European Economic Area (EEA), or on major U.S. stock exchanges, including the New York Stock Exchange (NYSE) and Nasdaq. The disclosure requirement applies to all financial years ending on or after 30 September 2013, obliging firms to report their greenhouse gas (GHG) emissions in a standardised format within their annual reports. This legislation represents a significant step in advancing corporate environmental transparency and aligns with global efforts to enhance climate-related disclosure and accountability. The U.K.'s adoption of this mandate positioned it as a pioneer in mandatory carbon reporting, influencing later international frameworks such as the EU Non-Financial Reporting Directive (NFRD) and the Task Force on Climate-related Financial Disclosures (TCFD) (Bolton & Kacperczyk, 2021b; Jouvenot & Krueger, 2019; Krueger et al., 2020).

Under the rules, companies must include in their Directors' Report the amount of greenhouse gas (GHG) emissions they have produced, both from direct activities (Scope 1) and from purchased electricity and heat (Scope 2), over the previous twelve months. As highlighted by Jouvenot and Krueger (2019), only a small proportion of U.K.-incorporated quoted companies are listed outside the country. For this reason, the analysis in this thesis focuses on firms trading on the Main Market of the London Stock Exchange. It is important to note that the London Stock Exchange is divided into two key segments: the Main Market and the Alternative Investment Market (AIM). The 2013 regulations apply only to Main Market companies, while firms listed on AIM are not subject to these disclosure requirements.

2.3 Reporting requirements

The U.K. mandatory carbon disclosure framework requires certain publicly listed companies to include detailed information about their GHG emissions in their annual reports. Firms must report two leading indicators, including total emissions and emissions intensity. Either total or emissions intensity (absolute emissions) refer to the aggregate quantity of GHGs produced over the financial year, expressed in metric tons of carbon dioxide equivalent ($MtCO_2e$). The regulation separates emissions into two categories. Scope 1 covers direct emissions from sources owned or directly controlled by the company, while Scope 2 relates to indirect emissions that result from purchased energy, such as electricity, heating, cooling, or steam supplied by external providers.

Alongside these totals, firms are also required to disclose their emissions intensity. This measure is calculated by comparing total GHG emissions to an operational metric that reflects the scale of business activity, such as sales or output. This ratio provides stakeholders with insights into the efficiency of a firm's operations regarding its carbon footprint. Importantly, the regulation requires disclosure only of Scope 1 and Scope 2 intensities. Scope 3 emissions, covering all other indirect emissions along the value chain, including those from suppliers or customers, are excluded from the mandatory requirements.

Furthermore, firms are obligated to transparently disclose the methodologies utilised to calculate both absolute GHG emissions and emissions intensity. This methodological transparency is crucial for ensuring the comparability and reliability of the reported data across different reporting periods and among various companies. All these disclosures are required to be incorporated into the Directors' Report, a statutory document filed annually under U.K. company law.

2.3.1 Scopes of carbon emissions defined by the GHG protocol

The Greenhouse Gas (GHG) Protocol[7] divides corporate emissions into three categories to distinguish between direct and indirect sources. **Scope 1** covers direct emissions from activities owned or controlled by the firm. These usually come from the burning of fuels in company-operated facilities or equipment, such as boilers, furnaces, or vehicles. **Scope 2** refers to indirect emissions arising from purchasing electricity, steam, heating, or cooling. Although the emissions occur at external facilities, they are directly tied to the company's energy consumption and operational choices. **Scope 3** includes all other indirect emissions across the firm's value chain. This category is broad, covering emissions linked to suppliers, transportation, waste management, and the use of the company's products or services. For example, in the automotive industry, Scope 3 would include emissions from customers driving cars produced by the manufacturer. Evidence suggests that Scope 3 often makes up the largest share of a firm's total carbon footprint.

[7] Developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) in 1998 to provide a single global framework for organisations to measure, track, and disclose their GHG emissions in a comparable and transparent way.

Under the U.K. law, companies must report emissions of specific greenhouse gases, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). These gases are not disclosed separately but must be presented as a combined figure, expressed in tonnes of carbon dioxide equivalent (tCO_2e). Alongside reporting total Scope 1 and Scope 2 emissions, firms are also required to publish a carbon intensity measure. This metric relates total emissions to a business activity indicator, such as revenue or cost of goods sold, so that stakeholders can evaluate a company's emissions relative to its scale of operations. This standardised approach enables comparability across firms and sectors, facilitating more informed investment decisions and policy assessments.

In this thesis, carbon emissions are expressed in thousand tonnes of carbon dioxide equivalent (thousand tCO_2eq) to enhance clarity and facilitate interpretation of analytical findings. Specifically, the analysis uses carbon intensity as the primary metric, defined as the quantity of GHG emissions normalised by a firm's annual sales or revenues, measured in millions of U.S. dollars (thousand tCO_2eq per USD 1 million revenue). I use revenues as the normalising factor due to their strong correlation with the scale of a firm's operations, thereby offering a consistent and meaningful basis for comparison across firms, particularly within the same industry.

Carbon intensity metrics are especially valuable as they enable the comparison of emissions performance across firms of varying sizes and across different industries (Hoffmann & Busch, 2008). By controlling for firm-specific characteristics such as scale and operational scope, carbon intensity provides a standardised measure of environmental efficiency. Moreover, this metric allows for the examination of potential relationships between GHG emissions and financial performance or risk. Specifically, by relating emissions to revenue, carbon intensity reveals the degree to which a firm's financial activities depend upon practices associated with greenhouse gas production, thus highlighting potential vulnerabilities or strengths in terms of environmental sustainability and economic resilience.

2.4 Disclosure locations

The U.K. mandatory carbon disclosure regulation requires that disclosures related to GHG emissions must be included within the Directors' Report, a critical component of annual financial reporting for limited companies under U.K. company law. This requirement embeds environmental accountability directly into the financial reporting framework, ensuring that emissions data is as visible and integral to corporate assessments as financial performance metrics. The Directors' Report serves a function similar to the SEC Form 10-K in the United States, providing a comprehensive overview of a company's operations and performance over the fiscal year (Krueger, 2015).

The inclusion of GHG emissions data in the Directors' Report reflects the U.K. regulations' emphasis on integrating environmental considerations into corporate governance. As part of this integration, the Strategic Report has been added as a new section within the Directors' Report, further reinforcing the importance of strategic considerations related to sustainability and environmental impact. The requirement for GHG emissions disclosure in the Directors' Report ensures that this information is not only accessible to investors and stakeholders but also subject to the same level of scrutiny and accountability as financial data. Furthermore, by mandating the inclusion of emissions data in such a pivotal report, the regulation underscores the importance of transparency and accountability in corporate environmental performance. This approach facilitates informed decision-making by investors, who can assess a company's environmental impact alongside its financial health, thereby promoting a holistic view of corporate success.

In conclusion, the integration of emissions data into the Directors' Report highlights the evolving role of firm reporting in addressing environmental challenges. It signifies a shift towards a more comprehensive understanding of corporate responsibility, where success is measured not only by financial metrics but also by contributions to sustainability and reductions in environmental impact. This regulatory framework thus serves as a model for embedding environmental accountability into the core of corporate governance, offering insights for other countries seeking to enhance the visibility and relevance of sustainability disclosures within their financial reporting systems.

2.5 What makes the U.K.'s mandated carbon disclosure unique

The United Kingdom’s 2013 mandatory carbon disclosure, introduced through *The Companies Act 2006 (Strategic Report and Directors’ Report) Regulations 2013*, is widely regarded as the first regulation of its kind worldwide. It represented a significant departure from existing environmental disclosure frameworks, both in Europe and globally, and has been recognised as a pioneering step in linking carbon reporting with corporate governance. Unlike most other disclosure regimes at the time, which were voluntary or based on flexible “comply or explain” mechanisms, the U.K. regulation created a legally binding obligation for all quoted companies to disclose their GHG emissions in the Directors’ Report.

A key feature of the U.K. approach was its integration into corporate law. By embedding GHG disclosure within the Companies Act 2006, emissions data appeared in the same statutory filings as audited financial accounts. This design elevated carbon reporting to the same level of scrutiny as financial performance, ensuring oversight not only by regulators but also by auditors and investors. In other jurisdictions, environmental disclosures were often separated from corporate law and financial reporting, appearing instead in stand-alone sustainability reports or submitted directly to environmental regulators, as in the case of the United States Environmental Protection Agency (EPA) program.

Another distinctive element of the U.K. regulation was the breadth of company coverage. The disclosure requirements applied to all U.K.-incorporated quoted companies, including those listed on the London Stock Exchange Main Market, EEA exchanges, and major U.S. exchanges such as the NYSE and NASDAQ. This market-based approach differed from other countries where reporting obligations were triggered only for firms in high-emission sectors or for those exceeding certain thresholds, such as the facility-level reporting thresholds in Australia or Canada. In the U.K., if a company was listed, it had to disclose, regardless of its emissions profile.

The regulation was also prescriptive in terms of content. Companies were required to disclose absolute Scope 1 and Scope 2 emissions, at least one emissions intensity ratio, and the methodology used to calculate these figures. Such specificity marked a contrast with voluntary frameworks such as the Carbon Disclosure Project (CDP)[8] and Global Reporting Initiative (GRI)[9], which provided flexibility in what and how companies reported. This prescriptiveness enhanced standardisation and comparability across firms. Investors, who had previously faced difficulties comparing firm-level emissions data due to inconsistent reporting formats, now had access to more reliable and directly comparable information.

[8] The Carbon Disclosure Project (CDP) is a global non-profit organisation that operates the world's largest environmental disclosure system. Founded in 2000, CDP provides a platform for companies, cities, states, and regions to voluntarily report information on their environmental performance, particularly in relation to climate change, greenhouse gas (GHG) emissions, water security, and deforestation.
[9] The Global Reporting Initiative (GRI) is an international organisation that provides the world's most widely used standards for sustainability reporting. Its framework covers a broad range of ESG issues and is designed to inform not only investors but also a wide group of stakeholders such as employees, communities, and regulators.

The regulation's investor orientation further distinguished it from other regimes. By requiring disclosure in the Directors' Report, which is intended primarily for shareholders, the legislation framed carbon data as financially material information. This perspective differed from other jurisdictions, where disclosures were typically presented as matters of public transparency, corporate social responsibility, or environmental compliance. In the U.K., the link between carbon reporting and financial accountability was made explicit, reinforcing the idea that emissions performance could influence investor decision-making and corporate valuation.

Timing also underscored the regulation's pioneering nature. In 2013, the U.K. became the first country to impose mandatory GHG reporting through corporate law. France's Grenelle II, introduced earlier in 2010, required broader ESG disclosure but was less prescriptive about emissions metrics. The EU's Non-Financial Reporting Directive, adopted in 2014, applied on a "comply or explain" basis and lacked detailed guidance on format and content. Meanwhile, the U.S. EPA's mandatory GHG reporting program, which has been in place since 2009, required detailed facility-level data but was directed at regulators rather than investors.

Evidence suggests that the U.K. regulation had measurable financial impacts. By providing standardised and comparable GHG data, it enabled investors to apply greater pressure on high-emission firms. Institutional investors were better able to discriminate between companies on the basis of emissions intensity, leading to observable shifts in investment patterns and even equity valuations. This outcome demonstrates how prescriptive, investor-facing disclosure rules can influence corporate behaviour and capital allocation more directly than broad or voluntary reporting regimes.

Overall, these features gave the U.K. regulation a unique balance. It was narrow in scope, focusing only on quoted companies and only on carbon emissions, but it was deeply integrated into corporate law and financial reporting. This contrasts with broader but less standardised frameworks such as France's Grenelle II, regulator-focused schemes such as the U.S. EPA program, and flexible "comply or explain" initiatives such as the EU's NFRD. Its precision, prescriptiveness, and market integration combined to make the U.K. model distinctive.

In conclusion, the U.K.'s 2013 mandatory carbon disclosure stands apart because it transformed carbon reporting into a matter of company law, required standardised and comparable disclosures, targeted all listed companies regardless of emissions levels, and was the first national legal mandate of its kind. Its integration into securities market oversight made GHG disclosure a listing requirement, ensuring visibility to investors and embedding environmental accountability in the core of corporate governance. This unique combination of legal force, prescriptiveness, and financial relevance marked the U.K. as a pioneer in global climate disclosure regulation.

2.6 Carbon Pricing Regulation and Its Relationship to Mandatory Carbon Disclosure

Climate policy frameworks typically combine price-based instruments and information-based regulation to influence corporate behaviour. Carbon pricing policies impose an explicit monetary cost on greenhouse gas emissions, thereby altering firms' production decisions, investment incentives, and abatement strategies. In contrast, mandatory carbon disclosure represents an information-based regulatory intervention that requires firms to measure and publicly disclose their emissions without directly penalising emissions through prices or taxes.

Although both instruments aim to address climate-related externalities, they operate through fundamentally different economic channels. Carbon pricing primarily affects firms by increasing marginal production costs and incentivising emissions reductions through financial pressure. Mandatory carbon disclosure, by contrast, reshapes the information environment by enhancing transparency, comparability, and credibility of emissions data, thereby enabling investors and other stakeholders to more effectively monitor firms' environmental performance. This conceptual distinction is central to the interpretation of the empirical analyses conducted in this thesis, which focus on second-order effects operating through information, governance, and investor behaviour rather than on firms' direct emissions responses.

During the sample period examined in this thesis, the principal carbon pricing mechanism operating across Europe was the European Union Emissions Trading System (EU ETS). The EU ETS is a cap-and-trade system under which regulated firms must hold emissions allowances corresponding to their verified carbon emissions, with each allowance granting the right to emit one tonne of carbon dioxide. Allowances are tradable in secondary markets, allowing firms to adjust compliance strategies over time. Prior research documents that, particularly in the post-financial-crisis period, allowance prices under the EU ETS were relatively low and volatile, thereby weakening the strength and consistency of the carbon price signal faced by firms (Martin et al., 2016). As a result, the EU ETS during much of the sample period is widely regarded as exerting limited short-run pressure on firms' economic behaviour outside of heavily regulated sectors.

In the United Kingdom, carbon pricing differed from that in other European countries due to the introduction of the *carbon price floor (CPF)* in 2013. The CPF was designed to supplement the EU ETS by establishing a minimum effective carbon price for electricity generators. When EU ETS allowance prices fell below the government-specified floor, a top-up charge was levied on fossil fuels used in electricity generation. Consequently, electricity producers in the UK faced higher effective carbon prices than comparable firms elsewhere in Europe. Importantly, the CPF applied directly only to the electricity generation sector, although indirect effects may have arisen through higher electricity prices faced by downstream users.

The UK's mandatory carbon disclosure regulation, also introduced in 2013, represents a fundamentally different form of policy intervention. Rather than imposing direct costs on emissions, the regulation required UK-incorporated listed firms to disclose their greenhouse gas emissions in a standardised and publicly accessible format. This requirement altered the information available to capital market participants by improving the visibility, consistency, and comparability of emissions data across firms. A growing literature emphasises that disclosure-based regulation affects firms primarily through information and governance channels. Mandatory disclosure reduces information asymmetries, strengthens external monitoring, and enables investors to more accurately assess firms' exposure to climate-related risks and environmental performance. Empirical evidence shows that such disclosure requirements influence investor behaviour, ownership structure, and corporate financial policies through enhanced transparency rather than through direct cost mechanisms (Grewal et al., 2017; Jouvenot & Krueger, 2019).

Although carbon pricing formed part of the broader policy environment during the sample period, this thesis does not attempt to explicitly model or disentangle the causal effects of carbon pricing for several reasons. **First**, carbon pricing policies such as the EU ETS and the UK CPF are economy-wide, gradual, and sector-specific, rather than discrete firm-level shocks that vary sharply across time. These characteristics make them ill-suited to empirical identification strategies that rely on sharp regulatory discontinuities, such as difference-in-differences designs centred on clearly defined policy introduction dates. **Second**, the research questions addressed in this thesis focus on second-order effects operating through information, transparency, and governance channels, specifically institutional ownership, dividend policy, and abnormal cash holdings, rather than on firms' direct operational or emissions responses to cost-based regulation. Explicitly modelling carbon pricing would therefore shift attention away from the thesis's core contribution, which lies in understanding how changes in the information environment affect investor behaviour and corporate financial decision-making.

Third, this modelling choice is consistent with established practice in the disclosure literature. High-quality empirical studies explicitly acknowledge the existence of contemporaneous carbon pricing policies but do not model them directly. For example, studies examining the UK's 2013 carbon disclosure mandate explicitly discuss the UK CPF but do not include carbon price controls in their empirical specifications (Downar et al., 2021; Jouvenot & Krueger, 2019). Instead, potential confounding effects are addressed through sample design choices, such as the inclusion of industry fixed effects in the model. Similarly, studies of mandatory corporate carbon disclosure and mandatory non-financial reporting focus on transparency effects without attempting to disentangle these effects from contemporaneous carbon pricing mechanisms.

While carbon pricing represents a potential alternative explanation for changes in firm behaviour following 2013, several considerations suggest that it does not confound the core findings of this thesis. **First**, carbon pricing and mandatory carbon disclosure operate through distinct and largely orthogonal channels. Carbon pricing affects firms' marginal costs and emissions incentives, whereas mandatory disclosure primarily affects investor perceptions, monitoring intensity, and governance outcomes. Prior literature suggests that institutional ownership, dividend policy, and corporate cash holdings are highly responsive to changes in disclosure quality, monitoring, and investor protection (Bushee & Noe, 2000; Dittmar et al., 2003). In contrast, carbon pricing mechanisms such as the EU ETS primarily generate real effects concentrated in energy-intensive sectors, with limited evidence of broad capital market reallocation effects (Martin et al., 2014). Accordingly, the dependent variables examined in this thesis are more plausibly driven by transparency-induced investor scrutiny than by modest, sector-specific carbon pricing changes.

Second, the direct application of the UK carbon price floor was limited to electricity generation, whereas the empirical analyses in this thesis are conducted on a broad cross-section of firms across multiple industries. Although electricity generation firms are retained in the sample, the primary outcomes analysed reflect financial and governance responses rather than production or cost adjustments. Moreover, all empirical models include industry fixed effects, which control for time-invariant differences across industries, including baseline exposure to energy and environmental regulation. As a result, the inclusion of electricity generation firms is unlikely to drive the documented results.

Third, the empirical design focuses on relative changes between UK and non-UK European firms around the introduction of mandatory carbon disclosure. Carbon pricing policies, while relevant for contextual interpretation, do not constitute a discrete information shock that aligns precisely with the timing of the disclosure mandate. Consequently, it is unlikely that carbon pricing alone explains the systematic changes in investor behaviour and corporate financial policies documented in the empirical chapters.

Consistent with Jouvenot and Krueger (2020), this thesis conceptualises mandatory disclosure as a salient information shock that operates through investor attention, transparency, and monitoring channels. While acknowledging that firms operate under multiple overlapping climate policies, the analysis treats carbon pricing as part of the institutional background rather than as a focal explanatory variable. This approach mirrors standard practice in the disclosure literature, which recognises contemporaneous policy environments but interprets empirical results primarily through changes in information availability and governance mechanisms rather than through cost-based regulation.

In summary, carbon pricing policies such as the EU ETS and the UK carbon price floor form an important part of the institutional environment in which mandatory carbon disclosure was introduced. However, carbon pricing and disclosure regulation differ fundamentally in their objectives, mechanisms, and channels of influence. Consistent with high-quality empirical research, this thesis treats carbon pricing as contextual background rather than as a primary explanatory variable. By doing so, the analysis maintains a clear focus on the transparency and information effects of mandatory carbon disclosure, while explicitly acknowledging the broader climate policy framework within which firms operate.

Chapter 3: Carbon Intensity and Investor Heterogeneity: Evidence from a Quasi-Natural Experiment

3.1 Introduction

In recent years, institutional investors have increasingly integrated environmental, social, and governance (ESG) considerations into their investment strategies, reflecting a shift towards sustainable finance. This trend is particularly evident in the growing attention to firms' carbon emissions, a key component of climate-related risks, that can materially impact financial performance (Krueger et al., 2020). Empirical studies have demonstrated that climate risks significantly influence investment portfolios (Galema et al., 2008; Krueger et al., 2020). Consequently, many institutional investors now assess the carbon footprints of their portfolios, considering not only financial returns but also environmental and social metrics (Dyck et al., 2019). Ilhan et al. (2023) found through their survey that reporting on climate-related risks is viewed as equally important as financial reporting, with nearly one-third of participants rating it as even more significant. However, institutional investors believe that the existing disclosures lack clarity and fail to provide meaningful information. This has led to stricter disclosure regulations in some countries, requiring firms to report their environmental impacts in a standardised way, such as the U.K. mandatory carbon disclosure.

However, theories on ESG investment suggest that investors have varying preferences or beliefs regarding ESG factors (Starks et al., 2017). For example, the study of Marshall et al. (2022) indicates that heterogeneity in how foreign institutional investors invest in socially responsible investee firms differs. Theoretical frameworks suggest that investors exhibit heterogeneous preferences and beliefs regarding ESG issues, leading to varying investment behaviours (Starks et al., 2017). For instance, some investors prioritise ESG factors due to their potential to enhance long-term returns and mitigate risks, particularly downside risks (Albuquerque et al., 2019; Hoepner et al., 2024; Sautner & Starks, 2023). Others may be driven by non-pecuniary motives, aligning investments with personal or stakeholder values (Gibson Brandon et al., 2022; Hong & Kacperczyk, 2009). Furthermore, research indicates that investors from countries with strong environmental standards, and those required by law or fiduciary duty to consider climate risks, tend to place a higher value on climate risk reporting (Ilhan et al., 2023).

Given these divergent perspectives, it becomes essential to examine how various categories of institutional investors react to firms' carbon emissions once environmental disclosures are made. Understanding this relationship can shed light on the extent to which environmental considerations influence investment decisions across various investor profiles. The purpose of this chapter is to explore how firms' carbon emissions influence institutional investment, paying particular attention to the fact that institutional investors are not a uniform group. Different types of investors may react in distinct ways when assessing firms with varying levels of carbon intensity. By examining these differences, this study adds to ongoing discussions in sustainable finance about how investors contribute to the transition toward environmentally responsible business practices. To do this, this chapter specifically focuses on how reductions in firm-level carbon emissions affect patterns of institutional ownership. The analysis takes advantage of a quasi-natural experiment provided by the U.K.'s mandatory greenhouse gas (GHG) disclosure law, which obliges listed firms to publish emissions data using a standardised reporting format. Because the policy created an external shock to reporting practices and emissions management, it provides a useful setting for causal analysis. Furthermore, evidence from Jouvenot & Krueger (2019) shows that firms covered by the regulation responded by cutting both their total emissions and their emissions intensity by about 16% and 14%, respectively. Within this context, this chapter examines whether investors distinguished by investment horizon, governance style, or climate orientation adjusted their allocations in systematically different ways. This focus is motivated by prior work demonstrating that institutional investors differ greatly in how far they incorporate environmental considerations into their portfolio strategies (i.e. Ilhan et al., 2023; Krueger et al., 2020; Marshall et al., 2022; Starks et al., 2017).

I focus on institutional investors because they increasingly dominate global equity markets, accounting for a substantial share of market capitalisation (Matos, 2020). In this context, the reasons behind investors' consideration of climate risks in their investment choices can be financial, non-financial, or a mix of both (Krueger et al., 2020; Starks et al., 2017). Supporting this view, the study of Ilhan et al. (2019) indicates that many institutional investors regard climate risk reporting as equally important as traditional financial reporting and advocate for mandatory and more standardised disclosures. Nevertheless, institutional investors' opinions vary depending on their characteristics and beliefs about climate change. For instance, research using archival data finds that long-term investors are more likely to integrate ESG factors into their decision-making (Starks et al., 2017). Gibson et al. (2020) demonstrate that environmental performance matters more for investment returns when held over longer horizons, reinforcing the notion that investment time horizon plays a critical role in how sustainability is valued. Furthermore, existing literature argues that incorporating climate criteria into portfolio decisions can help reduce investment risk, thereby highlighting the financial relevance of environmental performance. Consistent with this argument, evidence increasingly shows that many institutional investors scrutinise firms’ carbon emissions and may reward low-emission firms with greater capital flows (Bolton & Kacperczyk, 2021b). Therefore, to understand how institutional investors allocate capital in response to climate concerns, it is essential to examine their underlying preferences and the economic weight they assign to environmental issues. Moreover, focusing on emissions reporting, if higher levels of environmental disclosure reduce information asymmetries and agency problems, they may improve transparency and governance, thereby attracting institutional investors. In this context, mandatory carbon disclosure may act as a signal of firm quality and long-term risk management. This chapter contributes to the literature by providing the first empirical evidence, based on a quasi-natural experiment, on how firm-level carbon emission reductions resulting from regulatory intervention affect capital allocation decisions by different types of institutional investors.

Employing the disclosure mandate as a source of exogenous variation, I examine two central research questions. First, I explore whether firms with lower carbon emissions attract greater investment from institutional investors, a hypothesis I refer to as the *carbon emissions reduction attraction hypothesis*. Second, I examine whether institutional investors respond heterogeneously to carbon reduction efforts based on differences in investment horizon, style, and climate-consciousness. I refer to this as the *institutional investors' heterogeneity hypothesis,* following the study of Marshall et al. (2022). To empirically assess these hypotheses, I apply a difference-in-differences (DiD) design to capture changes before and after the disclosure regulation using a 2013 U.K mandatory carbon disclosure as external shock, the identification strategy relies on comparing firms subject to the regulatory disclosure mandate (treated group) with those exempts from the requirement (control group), thereby enabling credible causal inference regarding the effects of emissions reductions on institutional ownership.

The quasi-natural experiment produces several key results. First, the evidence supports the carbon reduction attraction hypothesis that after the introduction of mandatory disclosure, institutional investors increased their holdings in firms that cut emissions. Second, the results confirm that institutional responses are not uniform. Investors with long-term horizons showed a stronger tendency to raise their stakes in compliant firms compared to short-term institutional investors. In addition, independent investors who are typically more active monitors demonstrated a greater inclination to support firms reducing emissions. A similar pattern is evident among climate-conscious investors, particularly those aligned with the Principles for Responsible Investment (PRI) and those operating in countries where strong environmental norms shape market behaviour. These outcomes remain consistent across multiple placebo tests, lending further credibility to the causal interpretation of the findings.

This study contributes to several strands of literature within accounting and finance, particularly regarding institutional investors' sustainability preferences and the relation between institutional ownership and firm carbon emissions. First, this thesis chapter advances the growing body of literature by examining how different types of institutional investors respond to environmental performance, specifically carbon emissions. A key issue in this field concerns the underlying motivations driving institutional investors to invest in sustainability-oriented practices. According to survey evidence reported by Krueger et al. (2020), one of the main reasons investors pay attention to climate risks is the desire to safeguard their reputation and maintain a positive public image. Moreover, some investors perceive that mitigating climate-related risks and reducing carbon emissions enhances long-term portfolio value. However, the extent to which such perceptions are uniformly held across different types of institutional investors remains inconclusive. Prior research has begun to address this heterogeneity. Starks et al. (2017) show that investors who hold assets over longer horizons tend to favour companies with stronger ESG records, indicating that sustainability performance aligns closely with their long-term strategies. Similarly, Gibson Brandon et al. (2022) highlight variation in ESG preferences across institutional investor types. More closely aligned with this study, Marshall et al. (2022) provide evidence that differences among foreign institutional investors matter greatly, showing in the Indian context that varying investor characteristics shape how they allocate capital to firms required to comply with mandatory corporate social responsibility (CSR) regulations. As motivated by the above studies, this study contributes by empirically examining whether heterogeneous types of institutional investors exhibit differential preferences toward firms based on their carbon emissions profiles. This focus provides nuanced insights into how sustainability considerations vary among institutional investors, especially in the context of the level of carbon emissions.

Second, this study adds to existing research on how institutional ownership relates to firms' environmental outcomes, with a particular focus on carbon emissions. While extant studies have largely focused on how institutional investors influence firms' environmental strategies and disclosures (e.g. Atta-Darkua et al., 2023; Benlemlih et al., 2023; Bolton & Kacperczyk, 2021a; Cohen et al., 2023; Ilhan et al., 2023), fewer have explored the reverse, namely, how firms' carbon emissions impact institutional investment decisions. Prior research indicates that institutional investors can play an active role in encouraging companies to strengthen their environmental practices (Azar et al., 2021; Dimson et al., 2015; Dyck et al., 2019). Ilhan et al. (2023) further show that firms with higher institutional ownership, especially when those investors come from countries with strong social and environmental norms, are more likely to provide extensive climate-related disclosures. Benlemlih et al. (2023), using data from the US and the U.K., demonstrate that institutional ownership correlates with lower GHG emissions. In this context, the present study contributes by documenting that firms with lower carbon emissions or those actively reducing their emissions are more likely to attract institutional capital, especially how the difference among types of institutional investors, thereby establishing a causality path from firm-level sustainability actions to investor behaviour.

Third, this study makes a methodological contribution to the literature on GHG emissions and institutional investment. Addressing the significant endogeneity concerns in this field, this study employs a novel identification strategy by combining a quasi-natural experiment with difference-in-differences (DiD). While this identification strategy has been used in other contexts, it is among the first to apply such a robust causal framework in the context of carbon emissions and institutional investor heterogeneity preferences. The identification strategy mitigates the bias arising from omitted variables in which institutional investors may allocate capital based on firm characteristics such as size, return on assets, and other financial metrics, rather than the firm's level of carbon emissions, which might confound the relationship between institutional investment and carbon emissions. To the best of my knowledge, this is the first study that uses a quasi-natural experiment of the difference-in-differences method to measure the effect of carbon emissions on institutional ownership to ensure that the results are valid and are not disturbed by endogeneity concerns. Thus, it enhances the comprehension of policy change implications in global financial markets and shows how firm-level carbon emissions affect institutional investor fund flows, contributing to economic growth.

This chapter proceeds as follows. Section 2 discusses the literature and explains how the research hypotheses are developed. Section 3 outlines the data sources and sample selection process and provides descriptive statistics. Section 4 sets out the empirical strategy and methodology. Sections 5 and 6 present the main findings along with robustness analyses, respectively. Section 7 presents the empirical analysis, showing how different types of institutional investors respond. The final section (Section 8) offers concluding remarks.

3.2 Related literature and hypothesis development

3.2.1 Corporate carbon emissions and institutional ownership

An expanding stream of research shows that institutional investors are paying closer attention to firms' environmental performance. Evidence from several studies points to a shift in investment practices shaped by climate concerns and sustainability objectives (Bolton &

Kacperczyk, 2021b; Flammer et al., 2021; Krueger et al., 2020; Riedl & Smeets, 2017; Sautner & Starks, 2023). Notably, Azar et al. (2021) demonstrate a strong negative link between institutional ownership, most prominently from the *Big Three* asset managers, and firms' subsequent carbon emissions. This finding underscores the increasing role of institutional investors in advancing ESG priorities. Building on this line of work, my study examines whether a regulatory intervention, in this case, the U.K.'s mandatory carbon disclosure policy, further shapes institutional ownership patterns. It is reasonable to assume that, following the disclosure regulation, institutional investors may be more likely to invest in firms with low carbon emissions. There are three key channels through which lower carbon emissions may attract greater institutional investment.

First, firms with lower carbon emissions may benefit from superior corporate governance, which in turn lowers their cost of capital. Environmental performance is often viewed as an integral part of a firm's broader CSR agenda. Enhanced CSR practices have been shown to reduce information asymmetry, increase transparency, and improve corporate disclosures (Dhaliwal et al., 2011). Firms with robust CSR disclosure often receive higher governance ratings, fostering investor confidence (Chan et al., 2014). Better corporate governance can make it easier to trade a company's shares and can also lower the cost of capital equity, mainly because it reduces uncertainty and the expenses linked to monitoring managers (Chung et al., 2010; Diamond & Verrecchia, 1991; Lambert et al., 2007). Research also shows that financial markets take sustainability into account, and companies with stronger environmental practices often face lower financing costs (Chava, 2014; El Ghoul et al., 2011).

Second, the growth of socially responsible investing, influenced by altruistic motives, reputational concerns, and social expectations, has led institutional investors to pay more attention to a firm's carbon performance. Survey evidence from Krueger et al. (2020) shows that protecting reputation and maintaining a positive public image are among the main reasons investors support sustainability-focused practices. Consistently, research in behavioural economics and finance suggests that investors may derive utility not only from financial returns but also from investing in alignment with their values (Ariely et al., 2009). Riedl & Smeets (2017) show that individual and institutional investors often prioritise social preferences in their portfolio decisions. These preferences are particularly salient in the context of climate change, where socially responsible investment strategies increasingly incorporate environmental screens (Hong & Kacperczyk, 2009; Pedersen et al., 2021).

Third, institutional investors may also be economically motivated to prefer low-carbon firms due to the financial risks posed by climate change. Climate-related risks, particularly regulatory risks, can have material impacts on firm valuation and long-term performance (Krueger et al., 2020). Anticipating stricter environmental regulations and carbon pricing mechanisms, investors may prefer firms that proactively manage their emissions as a means to protect and enhance portfolio value. Several studies support this perspective, suggesting that firms with stronger environmental practices are more resilient, experience fewer regulatory penalties, and enjoy better financial performance (Albuquerque et al., 2019; Lins et al., 2017; Sharfman & Fernando, 2008). Based on these arguments, I conjecture that firms with lower carbon emissions in line with disclosure requirements will attract more institutional investment, as outlined in the carbon reduction attraction hypothesis:

Hypothesis 1: Firms with carbon emissions reduction should attract greater levels of institutional investor investments.

It is important to note that the introduction of mandatory carbon disclosure in 2013 coincided with the implementation of the U.K. Carbon Price Floor, which increased the effective carbon price faced by U.K. firms relative to many European counterparts operating solely under the EU Emissions Trading System. A detailed discussion of the institutional background and the interaction between carbon pricing and disclosure regulation is provided in Section 2.6 of Chapter 2. While carbon pricing reforms primarily influence firms through cost and production channels by altering input prices and investment incentives, the mechanism examined in this chapter operates through an information channel. Mandatory disclosure enhances transparency, reduces information asymmetry, and enables institutional investors to more accurately assess firms' environmental performance. The empirical design, therefore, focuses on the differential capital market response associated with increased transparency rather than direct cost-based regulatory effects. Although carbon pricing forms part of the broader policy environment, the outcomes analysed in this chapter, particularly institutional ownership, are interpreted as reflecting investor responses to enhanced disclosure rather than carbon price differentials alone.

3.2.2 Investor heterogeneity hypothesis: Investment horizon

Institutional investors are becoming more important in directing corporate decisions, especially by using their capital to influence firms' performance on ESG issues. However, institutional investors are not a homogeneous group. Their preferences, priorities, and decision-making processes are shaped by various factors, including regulatory environments, financial objectives, and the social norms of their domiciled countries. Institutional investors are commonly classified according to their investment horizons. Long-term investors, such as pension funds, insurance companies, and sovereign wealth funds, typically maintain stable ownership positions and focus on sustainable value creation. In contrast, short-term investors, including hedge funds and high-frequency traders, tend to engage in more frequent trading and are primarily driven by short-term market opportunities rather than long-term performance. This distinction reflects differences in investment objectives, trading behaviours, and monitoring intensity (Bushee, 1998; Gaspar et al., 2005; Yan & Zhang, 2009).

Long-term institutional investors are typically motivated to engage in active stewardship and influence managerial decisions to enhance firm value (Ivanova, 2017). Such investors often favour strategies that mitigate long-term risks, including those related to environmental sustainability and carbon emissions. Numerous asset owners and investors believe that responsible investing, such as allocating capital to firms with strong ESG profiles, will pay off for the investors over the long-term returns (Starks et al., 2017). Accordingly, ESG investments are inherently aligned with a long-term investment horizon, implying that such strategies are particularly relevant to long-term investors in a firm. Empirical evidence also suggests that firms adopting carbon reduction initiatives experience superior long-term financial outcomes, partly due to regulatory preparation, cost efficiencies, and enhanced reputation (Erhemjamts & Huang, 2019; Yan & Zhang, 2009). These investors are also more likely to value ESG disclosures, as such transparency reduces information asymmetry and supports long-horizon valuation models (Christensen et al., 2021; Dhaliwal et al., 2011). Furthermore, consumer preferences increasingly drive corporate environmental initiatives. Firms that reduce emissions to meet customer expectations may enjoy enhanced customer loyalty, revenue growth, and brand differentiation. These outcomes align with the objectives of long-term institutional investors who seek sustainable returns and risk-adjusted performance over time. Moreover, long-term investors may actively encourage environmental practices through proxy voting, engagement, and capital allocation (Dimson et al., 2015).

Conversely, short-term institutional investors are primarily focused on short-run gains, often through frequent trading strategies that exploit information asymmetries (Bushee, 2001; Yan & Zhang, 2009). These investors are less likely to support firm-level sustainability strategies, especially those with delayed payoffs, as such initiatives may conflict with short-term performance metrics (Graham et al., 2005). Research shows that transient institutional ownership is negatively associated with firm investments in ESG and innovation due to their preference for liquidity and immediate returns (Ilhan et al., 2019; Kim et al., 2018). Furthermore, short-term investors may view environmental expenditures as costs rather than investments, leading to underappreciation of the long-term financial benefits associated with carbon reduction(Chava, 2014).

In light of the contrasting investment behaviours and strategic priorities of long-term and short-term institutional investors, their reactions to environmental initiatives are also expected to diverge. Long-term investors are more likely to direct capital toward firms that make meaningful progress in improving environmental practices, including reducing carbon emissions. In contrast, short-term investors tend to focus on immediate returns and place less weight on sustainability performance. Based on this reasoning, I suggest that long-term institutional investors are more responsive to environmental outcomes than their short-term counterparts. This forms the basis of the heterogeneity hypothesis as follows:

Hypothesis 2: Long-term institutional investors are more likely to invest in firms that reduce carbon emissions compared to short-term institutional investors.

3.2.3 Investor heterogeneity hypothesis: Monitoring role

Not all institutional investors have the same interests or operating procedures in firms (Brickley et al., 1988; De-la-Hoz & Pombo, 2016). This hypothesis explores how firm carbon emission reduction influences institutional investors based on their investment styles, distinguishing between independent investors and grey investors. This categorisation is based on the degree of business relationships between the investors and the companies (Chen et al., 2007; Ferreira & Matos, 2008; Marshall et al., 2022).

Independent investors, such as mutual funds and independent advisors, have minimal business connections with the firms they invest in, making them resistant to external pressures. In contrast, grey investors, including banks and insurance companies, often have significant ties to their investee companies, making them more sensitive or loyal to the management of these firms (Aggarwal et al., 2011). Monitoring is generally more straightforward and less costly for independent investors than for grey investors, who may hesitate to pressure company managers for changes that could jeopardise their business relationships (Chen et al., 2007). As mentioned above, grey investors have closer relationships with company insiders and thus have access to privileged information. As a result, they might not value the additional information provided by CSR or ESG activities as much as independent investors do (Aggarwal et al., 2011; Chen et al., 2018; Ferreira & Matos, 2008). Bebchuk & Hirst (2019), using a survey and in-depth interviews, also suggest that passive or grey investors are less motivated to engage in firm-specific monitoring.

Therefore, firms that reduce carbon emissions and disclose related information, as part of their broader CSR activities, may become more attractive to independent investors because such practices lower information and monitoring costs. Consequently, grey investors might not see as much value in the additional information provided by carbon emission activities and are less likely to invest in such firms compared to independent investors. Accordingly, I propose the following hypothesis:

Hypothesis 3: Independent institutional investors are more likely to invest in firms with reduced carbon emissions compared to grey institutional investors.

3.2.4 Investor heterogeneity hypothesis: Responsible investing

Next, I turn my attention to a particular group of institutional investors often referred to as responsible investors, namely the PRI (Principles for Responsible Investment) signatories[10]. Interest in this type of investment has grown steadily, with strategies defined by the incorporation of ESG factors into decision-making (Brandon et al., 2022). Through these practices, institutional investors have gained increasing influence over corporate environmental policies and actions. The PRI offers a framework that encourages investors to integrate ESG considerations into both portfolio decisions and ownership activities. By becoming signatories, investors voluntarily commit to six principles, which include embedding ESG issues into investment analysis and working with portfolio firms to strengthen their ESG performance.

There is growing academic and empirical support for the assertion that responsible investors, particularly those aligned with PRI principles, differ meaningfully in their investment behaviour compared to non-signatories. Research by Dyck et al. (2019) find that PRI signatories have a significantly greater impact on firms' environmental and social (E&S) outcomes over twice as much as non-signatory investors. This is attributed not only to investment selection but also to more active engagement and stewardship practices aimed at improving sustainability performance.

Similarly, Benlemlih et al. (2023) provide that institutional investors are increasingly sensitive to the environmental and social implications of their portfolio companies, with many adopting divestment or engagement strategies for firms failing to meet climate-related

[10] The Principles for Responsible Investment (PRI) is a United Nations supported initiative established in 2006 to promote the integration of environmental, social, and governance (ESG) factors into investment practices. It provides a voluntary framework that encourages institutional investors including pension funds, insurance companies, and asset managers to align their investment decisions with sustainable and responsible principles. By becoming PRI signatories, investors commit to adopting six voluntary principles that guide responsible investment behaviour. These include: (1) incorporating ESG issues into investment analysis and decision-making processes; (2) acting as active and responsible owners by integrating ESG considerations into ownership policies and practices; (3) seeking appropriate disclosure on ESG performance from investee firms; and (4) promoting awareness and acceptance of responsible investment principles across the investment industry.

performance standards. These investors are more likely to retain or invest in companies demonstrating credible carbon emission reduction efforts, aligning with broader stakeholder expectations and climate goals. Brandon et al. (2022) emphasise that responsible investors, especially those committed to PRI seek to allocate capital in ways that contribute to a more sustainable global economy. This ethical motivation extends beyond financial returns, reflecting a values-based investment philosophy in which environmental responsibility plays a central role, including carbon reduction. As carbon emissions are among the most critical dimensions of environmental impact and climate risk, they serve as a key focus area for responsible investors (Krueger et al., 2020). Furthermore, empirical studies support the evidence that PRI signatories are more proactive in aligning their investment portfolios with climate-conscious firms. For example, Grewal (2017) finds that institutional investors who prioritise ESG standards tend to overweight firms with superior environmental disclosures and performance, particularly in relation to carbon metrics. By contrast, non-PRI investors, often motivated more narrowly by financial performance, may be less responsive to environmental factors unless directly tied to risk-adjusted returns. Therefore, I expect that investors who are signatories to the PRI will allocate more capital to firms with stronger carbon performance than those who are not signatories, as follows:

Hypothesis 4: PRI-signatory investors are more likely to invest in firms with reduced carbon emissions compared to non-PRI signatories' institutional investors.

3.2.5 Investor heterogeneity hypothesis: Environmental social-norm country domicile

Norms can be defined as the views or beliefs of a group of people on how they should or shouldn't behave (Dyck et al., 2019). Social norms are important in determining how someone behaves in general, including their investment choices and their financial decision-making. Specifically, Kübler (2001) illustrates that norms affect individual choices under uncertainty, while Kim and Venkatachalam (2011) show how investors' preferences are shaped by societal attitudes toward firms' CSR. As a result, they also affect their behaviour and outcomes in stock market trading (Hong & Kacperczyk, 2009). Investors have a tendency to allocate their investments towards stocks that align with their norms. Furthermore, the existing study suggests that institutional investors' behaviour is not uniform, but varies systematically across different sociocultural contexts (Dyck et al., 2019).

In financial markets, Hong & Kacperczyk (2009) find that stocks associated with "sin" industries (e.g., tobacco, alcohol, gambling) are often underweighted by institutional investors domiciled in countries where such sectors are socially unacceptable. According to Baker and Nofsinger (2012), investors tend to choose firms that align with their norms, such as ethical, socially conscious, environmentally conscious, and faith-based investment, while avoiding stocks that are at conflict with their norms, such as stocks associated with sin, pollution, etc. Institutional investors could therefore increase their investments in firms with better carbon performance if they live in a community where there is a strong belief that firms should have a high level of social and environmental performance. With increasing urgency surrounding climate change, environmental social norms have become a powerful force shaping investment behaviour. Dyck et al. (2019) show that institutional investors based in countries with stronger environmental and social norms tend to positively shape the E&S practices of the firms in which they invest. Moreover, the literature finds that the positive impact on corporate ESG behaviour is not uniform across all foreign institutional investors but is contingent upon the social expectations of the investors' home countries. This argument is further reinforced by Krueger et al. (2020), who analyse investor perceptions of climate risk and conclude that institutional investors with a high degree of exposure to societal environmental values are more likely to integrate carbon emissions considerations into their investment decisions. Likewise, Liang & Renneboog (2017) show that institutional ownership is positively associated with environmental performance in firms, especially when investors originate from jurisdictions with strong environmental regulatory frameworks and public support for sustainability. Based on this reasoning, I expect that institutional investors based in countries with stronger environmental social norms will allocate more capital to firms with lower carbon emissions than investors from countries where such norms are less influential. This expectation leads to the following hypothesis.

Hypothesis 5: Institutional investors from countries with high social norms regarding environmental concerns are more likely to invest in firms with carbon emissions reduction compared to investors from countries with lower environmental social norms.

3.3 Data and summary statistics

In this empirical chapter, I construct an aggregated firm-level dataset covering the period 2010–2016. I select 2010 as the starting year because carbon emissions data are reported inconsistently prior to this year. The initial sample consists of publicly listed firms domiciled in European countries and includes firm-level information on institutional ownership, financial characteristics, and carbon emissions. Data on institutional ownership and firm financials are obtained from S&P Capital IQ and Refinitiv, while carbon emissions data are sourced from Trucost and accessed through S&P Capital IQ Global. Institutional investor types are classified using S&P Capital IQ definitions to capture differences in investor horizons and monitoring roles, consistent with the methodology in Marshall et al. (2022). Detailed definitions of all variables used in the analysis are provided in the Appendix to this chapter.

As reported in Table 3-1, the initial sample comprises 4,159 firms and 22,986 firm-year observations over the period 2010–2016. I first exclude financial firms (SIC codes 6000–6999), which operate under distinct regulatory and reporting frameworks that affect their financing and disclosure behaviour (Benlemlih et al., 2023; Ferreira & Matos, 2008; Kacperczyk et al., 2018). This screen reduces the sample to 3,543 firms and 19,623 firm-year observations. I then remove very small firms with a market value below USD 1 million, following Jouvenot and Krueger (2019), to mitigate data quality concerns and the influence of micro-cap firms. Next, I exclude firms exhibiting extreme growth patterns, defined as annual sales growth exceeding 500%, as well as firms reporting negative total assets or negative revenues. These exclusions follow Jouvenot and Krueger (2019) and are intended to avoid distortions arising from outliers, base-year effects, or data inconsistencies.

[Table 3-1 about here]

To focus on voluntary carbon disclosure behaviour, I further restrict the sample to firms that voluntarily report carbon emissions data prior to 2010 and continue to disclose emissions thereafter. Firms lacking greenhouse gas emissions data or institutional ownership information at any point during the sample period are excluded. Applying this final restriction yields an unbalanced panel of 647 firms and 4,529 firm-year observations across European countries, which forms the basis for the main empirical analyses in this chapter.

To separate the treatment and control groups, I use the introduction of the U.K.'s mandatory carbon disclosure as an external policy shock. Firms listed on the Main Market of the LSE, which are directly covered by this regulation, are classified as the treatment group. All other listed firms in European countries that are not subject to this regulation are designated as the control group. The details of the U.K. carbon disclosure regulation are provided in Chapter 2.

3.3.1 Key independent variables: Treatment (U.K.) and Control (European) groups

The initial aim of this study is to examine how the actual level of carbon intensity influences institutional ownership using a Difference-in-Differences-in-Differences (DiDiD) model using the interaction term *($Treated_i \times After_t \times Carbon_{it}$)*. Here, $Carbon_{it}$ represents the firm's total carbon emissions intensity, measured as thousands of tons of CO_2e per million USD of revenue. The variable $Treated_i$ is coded as one for firms incorporated in the U.K. and listed on the Main Market of the LSE, since these firms are directly affected by the carbon disclosure regulation. Firms not covered by the regulation serve as the control group and are defined as zero. The variable $After_t$ is coded as one from 2013 onwards for firms whose fiscal year ends on or after 30 September. For firms with earlier fiscal year-end dates, it takes the value of one beginning in 2014. In all other cases, it is set to zero. This specification allows for the estimation of whether institutional ownership responds differently to carbon intensity in treated firms relative to control firms, after the regulation takes effect. Additionally, to explore heterogeneity in ownership responses across different types of institutional investors, I estimate another triple-difference model incorporating the interaction *($Treated_i \times After_t \times Type_j$)*. The variable $Type_j$ is a binary indicator equal to one if investor *j* is classified as a long-term, independent, PRI-signatory, or based in a high environmental social-norm country, and zero if the investor is categorised as short-term, grey, a non-PRI signatory, or domiciled in a low environmental social-norm country. Detailed definitions of each investor type are provided in Appendix 3-A1 of this chapter.

Regarding carbon emissions data, this study utilises firm-level carbon emissions data sourced from Trucost to construct a measure of carbon intensity, expressed in thousands of metric tons of carbon dioxide equivalent (thousand tCO_2e). To ensure consistency in emissions reporting over time, the sample is further restricted to firms that have disclosed GHG emissions data since at least 2010. This restriction helps mitigate concerns that the results may be driven by firms that only began reporting emissions in response to regulatory changes (Jouvenot & Krueger, 2019).

The final sample spans the years 2010 to 2016 and includes firms across 23 countries. To construct the panel of U.K. firms covered by the 2013 disclosure rule, I use the legislative criteria, selecting companies that are incorporated in the U.K. and listed on the Main Market of the LSE.[11] These firms were identified using official listings and subsequently matched to data from Trucost and Refinitiv Workspace using fuzzy matching techniques based on company names. This process yielded 174 U.K. firms subject to the regulation, which is consistent with Jouvenot & Krueger (2019). For the control group, I compile a panel of firms listed on non-main markets of the U.K. stock exchanges. These firms are also identified using data from Trucost, Capital IQ, and Refinitiv. The resulting control group consists of 473 firms. I also control for event year (γ_t) and stock exchange (λ_s) fixed effects. *Year* dummies are included to address time trend effects, such as the aggregate decline in the proportion of dividend payers. *Stock-exchange* fixed effects capture country-level factors that do not change over time, such as the stage of economic development, cultural norms, or regulatory frameworks. I use robust standard errors clustered at the stock exchange-year level following Jouvenot & Krueger (2019) to account for the possibility that errors are not independently and identically distributed.

The analysis draws on multiple measures of carbon emissions, including Scope 1, Scope 2, and Scope 3 carbon intensity. Carbon intensity is calculated as total emissions (in thousand tCO_2e) divided by firm revenue (in million USD) to allow for comparability across firms. Emission data are reported in accordance with the Greenhouse Gas Protocol, which classifies emissions into three scopes. Scope 1 refers to emissions that come directly from activities or equipment the company owns or operates. Scope 2 represents indirect emissions that arise when

[11] See https://www.londonstockexchange.com/reports?tab=issuers The companies listed on the London Stock Exchange

the company uses energy supplied by others, such as electricity, heating, or steam. Scope 3 covers all other indirect emissions linked to the wider supply chain and product use, which lie outside the company's immediate control. This chapter analyses firm-level carbon emissions data and classifications of institutional investors to examine whether and how firms' emission reduction efforts attract different levels of institutional investment among various types of institutional investors.

3.3.2 Dependent variables

To examine whether firm-level carbon intensity influences institutional investment behaviour, the main dependent variables are categorised into eight different types. These include long-term vs. short-term investors (investment horizon), independent vs. grey institutions (monitoring role), PRI signatories vs. non-signatories (responsible investing), and investors domiciled in countries with high vs. low environmental social norms (environmental social norms countries domicile). The institutional ownership is obtained from S&P Capital IQ and encompasses equity holdings in firms listed across European countries. The dataset includes fiscal year-end ownership information at both the firm and individual investor levels, covering 8,828 unique institutional investors globally. Key variables comprise investor identifiers, investor domicile countries, investor classifications, investee firm domicile countries, and ownership percentages.

At the individual investor level, institutional ownership is denoted as IO_{jit}, which denotes the proportion of firm i's shares owned by investor j at the end of fiscal year t. To construct an aggregate firm-level measure for use in a differences-in-differences-in-differences (DiDiD) framework, I compute total institutional ownership as follows:

$$IO_{it} = \sum_{j=1}^{n} IO_{jit} \quad (3\text{-}1)$$

IO_{it} represents the total institutional ownership of firm i in year t, calculated by aggregating the shareholdings (IO_{jit}) of all institutional investors j. This method follows the approach commonly used in earlier studies (e.g. Marshall et al., 2022; Dyck et al., 2019).

In examining Hypothesis 3, whether responsible investment commitments influence institutional preferences toward low-carbon firms, I examine whether institutional investors that have signed the Principles for Responsible Investment (PRI) allocate more capital to firms with lower carbon emissions than investors who are not signatories. PRI members commit to integrating environmental and social (ES) factors into their investment decisions. Information on signatories is taken from the official PRI database[12] and then linked to global institutional equity holdings from S&P Capital IQ. The initial matching process is performed using the S&P Capital IQ Identifier Converter tool, followed by a manual re-check of all matches to ensure accuracy.

To test Hypothesis 4, which examines whether institutional investors from countries with differing levels of environmental and social norms exhibit varying propensities to invest in low-carbon firms, I again utilise investor data from S&P Capital IQ. Investors are classified based on the E&S norms of their domicile countries, following Dyck et al. (2019). Specifically, I use the Environmental Performance Index (EPI) developed by Yale University to distinguish between countries with high and low environmental norms. Investors from countries with an EPI score above the median are classified as domiciled in high social norm countries, while those from countries below the median are classified as domiciled in low social norm countries. There is substantial and persistent cross-country variation in E&S norms, with European nations ranking consistently high. Notably, the top five countries in terms of environmental norms are Finland, Germany, the Netherlands, Norway, and Sweden. In contrast, countries in

[12] See https://www.unpri.org/signatories/signatory-resources/signatory-directory?utm_source=chatgpt.com

Asia, Australasia, and Africa typically score lower. I leverage this variation to examine whether institutional investors from high-norm countries are more likely to allocate capital to firms with reduced carbon emissions.

3.3.3 Control variables

To address potential omitted-variable bias in examining the causal effect of corporate carbon emissions on institutional investment decisions, a comprehensive set of control variables is incorporated. These variables span firm-specific characteristics, country-level attributes, and bilateral factors between the firm (investee) and the institutional investor. Drawing on an existing literature on the preferences of institutional investors, both domestic and international, this analysis carefully accounts for firm size (*Size*) using the natural logarithm of market capitalisation and the natural logarithm of property, plant, and equipment (*PPE*) (for additional control in a robustness check). Larger firms are generally more attractive to institutional investors due to their market presence and perceived stability (Dahlquist & Robertsson, 2001; Falkenstein, 1996; Ferreira & Matos, 2008; Gompers & Metrick, 2001). I include a measure of leverage, calculated as total debt divided by total assets, since prior research suggests that institutional investors tend to favour firms with lower debt levels. This implies that highly leveraged firms are expected to attract less institutional ownership (Ferreira & Matos, 2008). To capture financial performance, I also control for return on assets (ROA), the book-to-market ratio (BM) in natural logarithm form, and the share of cash and short-term investments relative to total assets (Cash ratio). Institutional investors are often drawn to firms with robust financial metrics, including strong liquidity positions, which signal lower risk and greater financial flexibility (Dahlquist & Robertsson, 2001; Gompers & Metrick, 2001; Leuz et al., 2009; Marshall et al., 2022). I also adjusted for stock liquidity (*Turnover*), which is captured by turnover, defined as trading volume divided by the number of adjusted shares outstanding. Liquid stocks are typically preferred by institutional investors, who value the ability to quickly adjust their entry and exit positions with the expectation that more liquid firms will attract greater investment from institutional investors (Gompers & Metrick, 2001; Marshall et al., 2022). The firm's growth potential, proxied by annual sales growth, is included as an indicator of investment opportunities (*Investment Opportunity*). Firms exhibiting strong growth are generally more attractive to institutional investors seeking future returns (Doidge et al., 2007; Ferreira & Matos, 2008). Corporate governance is another important consideration. Firms with concentrated ownership structures, such as those dominated by controlling shareholders or families, may deter institutional investors due to concerns over potential expropriation of minority shareholders (Leuz et al., 2005). I include the proportion of closely held shares (*Closely held shares*) in the analysis, with the expectation that firms with less concentrated ownership are more likely to attract investment from institutional investors.

Investor recognition and market visibility are the key factors influencing institutional investment decisions, as suggested by market segmentation theories (Boehme et al., 2009; Ferreira & Matos, 2008). I account for analyst coverage (*Analyst*) as an indicator of a firm's market visibility, expecting firms with higher analyst coverage to be more attractive to institutional investors. Foreign sales serve as a proxy for a firm's global market presence and familiarity with global investors. It is noted that firms engaging in international business are more recognisable to foreign investors, potentially increasing their likelihood of investment (Ferreira & Matos, 2008). I also include the annual geometric stock rate of return (*Return*) to isolate the influence of institutional investment from powerful momentum and feedback trading effects (e.g., Carhart, 1997). This step is essential to verify that institutional investment decisions are driven by carbon emissions levels rather than just a reaction to recent high returns.

At the country level, variables such as GDP growth (*GDP growth*) and the rule of law (*Rule of law*), sourced from the World Justice Project, are included to capture the broader investment environment. Institutional investors typically prefer countries with stronger legal frameworks, developed markets, and lower transaction costs. I expect higher GDP growth levels and a stricter rule of law to be more likely to attract greater investment from institutional investors. Finally, to reflect the influence of long-term bilateral relations and market familiarity, a set of bilateral controls is included. I include firm-investor characteristics control variables to account for bilateral influence factors, including geographical distance (*Distance*), bilateral trade volume (*Bilateral trade*), common language (*Common language*), and shared borders (*Common border*) between the investor's and investee's countries. Closer proximity and shared cultural or economic ties are expected to increase the likelihood of investment. I present the definitions of all variables used in this chapter, together with their data sources, in the appendix.

3.3.4 Summary statistics

Table 3-2 presents summary statistics for the main variables used in the empirical analysis, based on a panel of 4,529 firm-year observations across European countries over the period 2010–2016. To reduce the influence of extreme values, all continuous variables are winsorized at the 1st and 99th percentiles. The mean total emissions intensity, defined as thousand tons of CO2e per million USD in revenues, is 0.4603. The sample firms are, on average, relatively large, with a mean market capitalisation (Size) of approximately USD 11,450.63 million. The average leverage ratio (Leverage), measured as total debt to total assets, is 23.5%, indicating that firms in the sample finance roughly one-quarter of their assets through debt. Prior research shows that larger firms typically hold lower leverage ratios because they have greater access to internal financing, more diversified operations, and stronger creditworthiness. Therefore, the observed leverage ratio suggests that the sample may consist of relatively large, established firms with stable financial positions. Average profitability, proxied by return on assets (ROA), is slightly above 5%, while the mean asset turnover ratio is

80.96%, reflecting the heterogeneity commonly observed in firm-level studies (La Porta et al., 1999).

[Table 3-2 about here]

Ownership characteristics reveal that closely held shares constitute, on average, 27.13% of outstanding equity, a factor that may influence both corporate transparency and the effectiveness of market discipline (Gillan & Starks, 2003). The average sales growth rate, used as a proxy for investment opportunities, is 6.42%, indicative of the relatively mature stage of development among the sampled firms. These features align with empirical patterns documented in prior studies (e.g. Bolton & Kacperczyk, 2021). Institutional ownership is substantial, averaging 42.69% of outstanding shares. Notably, long-term institutional investors account for the majority of this ownership, with an average holding of 41.84%. Independent institutions hold, on average, 39.41%, while investors categorised as high norms hold 41.98%. These ownership patterns support the extant literature emphasising the heterogeneity of institutional investors (e.g. Bushee, 2001; Dyck et al., 2019).

[Table 3-3 about here]

Table 3-3 presents a comparative analysis of firm characteristics between U.K. firms (treatment group) and their European counterparts (control group) during the pre-regulatory period. Two-sided *t*-tests are employed to evaluate the statistical significance of differences between the two groups. The table reports the mean values of key variables to illustrate observable distinctions in firm behaviour and structure prior to the implementation of mandatory disclosure regulations. The results indicate that European (control) firms exhibit significantly higher total GHG intensity than U.K. firms. Specifically, U.K. firms report a mean carbon intensity of 0.364, compared to 0.483 among European firms, a difference that is statistically significant at the 1% level. This distinction is especially pronounced in Scope 1 emissions, suggesting that U.K. firms may have operated under more efficient or stringent production processes even before regulatory mandates were introduced. These findings are consistent with prior literature (e.g., Jouvenot & Krueger, 2019), which suggests that firms subject to carbon disclosure requirements are more likely to reduce their emissions compared to those not subject to such regulations. In addition to environmental performance, firm-level characteristics also differ significantly between the two groups. U.K. firms tend to be smaller in size, exhibit lower financial leverage, and have a lower concentration of closely held shares compared to their European counterparts. Furthermore, U.K. firms demonstrate stronger operational performance, with a significantly higher return on assets (ROA = 7.43% for treatment firms). Meanwhile, country-level economic indicators such as GDP growth do not significantly differ between the two groups; the rule of law index is notably higher in the U.K., with a highly statistically significant difference. This finding aligns with the well-documented strength of the U.K.'s legal system in protecting investor rights (La Porta et al., 1998). Institutional ownership also differs markedly across the two samples. U.K. firms report significantly higher levels of institutional ownership (mean = 65.92%) compared to their European peers (33.08%). Not surprisingly, among the different institutional owners, non-PRI signatory institutional investors are the largest holders, with an average stock ownership of 65.98%, followed by long-term institutions with an average ownership of 64.67%. PRI-signatory investors and short-term institutional investors, in turn, are the smallest institutional owners.

[Table 3-4 about here]

In Table 3-4, I report the pairwise correlation coefficients among carbon intensity, firm-level characteristics, country-level variables, and different measures of institutional ownership for firms across European countries over the period 2010–2016. The table provides preliminary evidence on the associations between institutional ownership and firms' carbon performance, as well as an initial assessment of potential multicollinearity concerns. Consistent with the main hypothesis of this thesis, the results show a negative and statistically significant correlation of −0.18 between total institutional ownership (IO) and carbon intensity, significant at the 1% level. This finding suggests that firms with lower greenhouse gas (GHG) emissions intensity tend to attract higher levels of institutional ownership. Although this bivariate relationship does not imply causality, it offers initial support for the proposed link between institutional investors and firms' carbon performance and motivates the subsequent multivariate regression analysis.

More generally, the correlations among the explanatory and control variables are of modest magnitude. With the exception of institutional ownership measures that are mechanically related by construction, most pairwise correlations are well below commonly cited thresholds for multicollinearity concerns. For example, firm size and book-to-market ratio exhibit a correlation of −0.28, while book-to-market and ROA are correlated at −0.45. These values indicate that the firm-level control variables can be jointly included in the regression models without materially affecting coefficient estimates or statistical inference.

Of particular relevance to this chapter are variables (14) to (22), which capture total institutional ownership (IO) and its disaggregated components based on investment horizon, institutional characteristics, and norms orientation. I classify institutional investors according to predefined criteria, including investment horizon (long-term versus short-term), degree of independence, PRI affiliation, and norms orientation. As expected, total institutional ownership is highly correlated with several of its subcomponents. I note that these high correlations are normal in studies that decompose institutional ownership into related subgroups. Because the components are derived from total ownership, strong correlations between total institutional ownership and its categories, as well as among closely related investor types, reflect the underlying ownership structure of firms in the sample rather than indicating any data or specification problem.

Importantly, I design the empirical analysis to ensure that these correlations do not affect the main results. *First*, I do not include total institutional ownership and its disaggregated components simultaneously within the same regression specification. Instead, I examine different types of institutional ownership separately across models, which allows me to make clear comparisons between investor groups. *Second*, in several specifications, I use dummy variables to identify the presence or dominance of a particular type of institutional investor (for example, long-term versus short-term investors), rather than including multiple highly correlated continuous ownership measures in the same regression.

Overall, I interpret the correlation matrix reported in Table 3.4 as consistent with the theoretical construction of the ownership variables. The observed relationships support the validity of the empirical design and provide reassurance that multicollinearity does not drive the results presented in the subsequent analysis.

Figure 3-1 shows the evolution of Scope 1 GHG emissions intensity for U.K. (treated) and EU (control) firms around the introduction of the mandatory carbon disclosure regulation in 2013. Panel A presents the annual mean values, and Panel B reports the annual median values. The vertical dashed line indicates the year in which the regulation was implemented. Before 2013, I observe that U.K. and EU firms follow broadly similar trends in both the mean and median Scope 1 emissions intensity. The two series move closely together, and there is no clear divergence between treated and control firms. One exception appears in 2012, when emissions intensity for U.K. firms increases. This temporary increase may reflect firms beginning to measure and report their emissions more accurately in anticipation of the regulation, particularly as clearer guidance on emissions calculation became available.

[Figure 3-1 about here]

A sharp decline in Scope 1 emissions intensity for U.K. firms is visible between 2013 and 2014. This reduction is especially pronounced in the median (Panel B), where treated firms show a substantial immediate drop following the implementation of the regulation. The mean (Panel A) also declines, although the decrease is less pronounced than in the median. This pattern suggests that the regulatory intervention is associated with an immediate adjustment in emissions intensity, particularly for the typical treated firm. After 2014, Scope 1 emissions intensity among treated firms shows a slight upward movement. However, the levels remain consistently lower than those of EU firms. In contrast, carbon emissions intensity among control firms increases after the disclosure regulation. These findings are consistent with the main references of this chapter, particularly Downar et al. (2021) and Jouvenot and Krueger (2019), who document that U.K. firms reduced their greenhouse gas emissions following the introduction of mandatory disclosure requirements compared to European firms.

Figure 3-2 extends the analysis by examining absolute Scope 1 GHG emissions rather than emissions intensity. While Figure 3-1 focuses on emissions scaled by revenue, Figure 3-2 presents the evolution of total direct emissions generated from firms' own operations. Panel A reports the annual mean values, and Panel B presents the annual median values. As in Figure 3-1, the vertical dashed line indicates the implementation of the mandatory disclosure regulation in 2013.

[Figure 3-2 about here]

Before 2013, I observe that U.K. and EU firms display broadly similar trends in absolute Scope 1 emissions. The series move closely together, and there is no clear pre-treatment divergence between treated and control firms. This pattern is consistent with the parallel trends assumption and supports the identification strategy used in the empirical analysis. Following the introduction of mandatory disclosure in 2013, absolute Scope 1 emissions for U.K. firms decline relative to EU firms. The reduction becomes visible after the implementation year and is reflected in both the mean and median measures. The median shows a particularly clear adjustment, suggesting that the reduction is not driven solely by a small number of large emitters but reflects a broader change among treated firms.

Taken together with Figure 3-1, the evidence suggests that the regulation is associated not only with improvements in emissions intensity but also with reductions in absolute emissions. Consistent with the main references of this chapter, particularly Downar et al. (2021) and Jouvenot and Krueger (2019), the graphical evidence supports the view that U.K. firms reduced their greenhouse gas emissions following the introduction of mandatory disclosure relative to comparable European firms.

Figure 3-3 shows the evolution of institutional ownership for U.K. (treated) and EU (control) firms around the introduction of the mandatory carbon disclosure regulation in 2013. Before 2013, I observe that U.K. and EU firms follow broadly similar trends in both the mean and median levels of institutional ownership. The two series move closely together, and there is no clear divergence between treated and control firms. This parallel pattern supports the identification strategy and suggests that, in the absence of regulation, ownership structures would likely have evolved in a similar manner across the two groups.

[Figure 3-3 about here]

Before 2013, I observe parallel pre-trends between treated and control firms. Institutional ownership in both groups moves in a broadly similar direction, and there is no evidence of anticipatory divergence. Although U.K. firms exhibit a consistently higher level of institutional ownership than EU firms, this level difference remains stable prior to treatment. In a difference-in-differences framework, such persistent level differences are not problematic, as identification relies on trend similarity rather than identical levels. After 2013, institutional ownership among U.K. firms increases gradually relative to EU firms. The divergence is gradual and persistent rather than abrupt. The graph does not display a dramatic shock effect in 2013. Instead, it reveals a slow and steady institutional response. This pattern is theoretically sensible, as capital reallocation typically occurs progressively. Overall, Figure 3-3 indicates that mandatory carbon disclosure is associated with a sustained increase in institutional ownership among U.K. firms relative to EU firms. The absence of pre-treatment divergence and the post-2013 upward trend among treated firms provide visual support for a capital market response to enhanced environmental disclosure.

3.4 Research design

To examine the effect of carbon emissions reduction on different types of institutional investors, this study begins by investigating whether such reductions lead to increased institutional investment. A double difference-in-differences (DiDiD) approach is employed, using the 2013 U.K. mandatory carbon disclosure regulation as an exogenous shock. Specifically, the main aim of my first empirical chapter is to identify the causal link between a firm's carbon intensity and the extent of its institutional ownership, while paying particular attention to how this relationship differs across types of institutional investors. The U.K. disclosure regulation serves as an exogenous shock, under the premise supported by Jouvenot and Krueger (2019) that the policy compels firms not only to report their greenhouse gas (GHG) emissions but also to reduce them. This aligns with a broader body of literature that links mandatory environmental disclosures with subsequent improvements in firm-level environmental performance.

The regulation, introduced under the Companies Act 2006 (Strategic Report and Directors' Report) Regulation 2013, applies only to firms listed on the U.K.'s Main Market. Firms listed on the Alternative Investment Market (AIM) are exempt. This distinction creates a natural treatment and control setting: publicly listed Main Market firms subject to the regulation constitute the treated group, while AIM-listed firms, along with firms from 23 other countries unaffected by the U.K. regulation, serve as the control group. This framework enables me to identify how carbon disclosure and subsequent emission reductions influence institutional investment behaviour. The rule came into force on 30 September 2013, obliging firms to include detailed GHG emission data in their annual reports. According to Jouvenot and Krueger (2019), this mandate led to a 16.43% reduction in total GHG emissions and a 14.18% decrease in GHG intensity (emissions per unit of tangible assets) among U.K. firms. These outcomes suggest that the policy created a regulatory environment conducive to emissions reductions, validating its use as a quasi-natural experiment in this study. I treat the regulation as an external shock and use a DiDiD approach to test its impact. The analysis compares changes in institutional ownership before and after the rule, while accounting for industry, country, and firm-specific factors. In addition, this study further explores the heterogeneous responses of institutional investors through a difference-in-difference-in-differences (DiDiD) approach. This extended framework examines how investor behaviour varies depending on attributes such as investment horizon, investment style, climate-consciousness, and the normative pressures associated with the institutional investor's country of domicile. The specific empirical models used to test each hypothesis are detailed in the empirical results section.

3.4.1 Parallel trend assumption

A potential concern regarding the results is that pre-existing differences between firms in the U.K. and those in other European countries may bias the estimated effects of the disclosure regulation. Such differences could confound the observed changes in institutional investment. In particular, firms with higher levels of institutional ownership may possess distinct characteristics such as larger size, greater visibility, or stronger governance structures that systematically differentiate them from firms with lower ownership levels. If these firm-level attributes are correlated with both institutional ownership and carbon intensity, the primary findings may reflect underlying structural differences rather than the causal impact of the regulation.

For example, prior literature documents that larger firms tend to attract greater institutional investment due to their higher visibility, more stable earnings, and stronger information environment (Jouvenot & Krueger, 2019). Firm size may therefore act as an important underlying determinant of institutional ownership, potentially confounding the relationship between carbon performance and capital allocation. Accordingly, it is necessary to account carefully for such firm characteristics to ensure that the estimated effects are not driven by observable differences unrelated to carbon intensity.

To test this, I use Figure 3-4 to show how institutional ownership differs between U.K. firms (treatment group) and European firms (control group) around the introduction of the regulation. I apply a difference-in-differences (DiD) framework with controls and fixed effects, following the approach of Jouvenot and Krueger (2019) using model 3-2. In this setup, I replace the *After* dummy with year-specific indicators for 2010–2016, using 2012 as the reference year. This allows me to compare average ownership patterns before and after the regulation across the two groups. The purpose of this test is to check the assumption of parallel trends. If the gap in institutional ownership only appears after the regulation is implemented, it suggests that both groups were on similar paths beforehand, which strengthens the credibility of my identification strategy.

In line with the approach adopted by Jouvenot and Krueger (2019a), this thesis does not apply propensity score matching (PSM) prior to implementing the DiD methodology. The validity of DiD estimates depends on the parallel trend assumption that, in the absence of treatment, the treated and control groups would have, on average, experienced similar changes in outcomes over time. While PSM aims to balance observed pre-treatment covariates between groups, it does not ensure alignment in pre-treatment outcome trends, which are critical for the DiD framework (King & Nielsen, 2019). Moreover, using propensity score matching (PSM) may remove observations that cannot be matched, which can lower statistical power and create selection bias. To avoid these issues, I do not apply PSM. Instead, I check whether the treatment and control groups display similar outcome patterns before the regulation, consistent with the assumption of parallel trends in the DiD approach. Evidence supporting this comparability is presented in Figure 3-4.

Equation (3-2) sets out the DiD model, which measures how institutional ownership changes for treated firms compared to control firms after the regulation takes effect.

$$IO_{it} = \alpha + \beta_1.(Treated_i \times After_t) + \beta_2.\ Treat_i + \beta_3.\ After_t + \beta_4.\ \boldsymbol{X}_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it} \qquad (3\text{-}2)$$

In this model, IO_{it} represents the share of firm i's equity owned by institutional investors at year t. The interaction term ($Treated_i \times After_t$) serves as the DiD variable, capturing the effect of the regulation on the treated firms. The vector X_{it-1} includes one-year lagged firm-level control variables. Fixed effects are incorporated at the stock exchange (λ_s) and year (γ_t) levels to account for unobserved heterogeneity. I cluster the standard errors at the stock exchange-year level.

[Figure 3-4 about here]

Figure 3-4 shows the estimated yearly difference in institutional ownership between U.K. firms (treatment group) and European firms (control group), using 2012 as the reference year. The outcome variable is the proportion of each firm's equity owned by institutional investors. The figure displays point estimates and 95% confidence intervals for the interaction between the treatment group indicator and a series of year-specific dummy variables centred around the regulation's introduction. Crucially, the estimates prior to the implementation of the regulation are statistically insignificant, with confidence intervals that intersect the zero line (the shaded area does cross the horizontal red line). This finding supports the assumption of parallel trends, indicating that institutional ownership in U.K. and European firms evolved similarly prior to the policy change. Therefore, the increase in differences in institutional ownership after the regulation is likely driven by the policy itself, rather than by any prior disparities between the groups. Figure 3-4 thereby reinforces the validity of my identification strategy and suggests that the main results are not confounded by pre-regulation differences in institutional investment levels.

3.5 Baseline results: Do actual firm-level carbon emissions matter for institutional ownership?

The ideal theoretical framework for estimating the effect of carbon emissions on institutional ownership would be a controlled experiment. In such a design, two groups of firms would be created, one subjected to a carbon disclosure intervention, and the other serving as a counterfactual (Jouvenot & Krueger, 2019). Since conducting a true experiment is impractical in this context, I approximate this approach by using a quasi-natural experiment based on a U.K. regulation that requires firms to report their GHG emissions in annual filings. In this empirical design, U.K. publicly listed firms that are subject to the mandatory carbon disclosure regulation constitute the treatment group, while comparable listed firms from other European countries, where the regulation does not apply, serve as the control group. This cross-country setting allows for a Difference-in-Differences (DiD) identification strategy, enabling the isolation of the regulation's causal effect on firm outcomes by comparing treated and untreated firms before and after the policy intervention.

To examine the hypotheses regarding the relationship between carbon intensity and institutional investors' investment decisions, I conduct tests from two distinct perspectives. First, I examine how institutional ownership at the firm level relates to corporate carbon emissions. Second, I test the hypotheses at the investor level by breaking down institutional ownership to evaluate whether investors with different horizons, strategies or climate-conscious orientations vary in their likelihood of investing in firms that reduce their emissions.

The empirical model is presented in Equation (3-3), where β_1 captures how institutional ownership changes after the regulation, taking into account the actual emission levels of U.K. firms compared with those of European firms. This coefficient, β_1, is the main coefficient of interest. If the reduction of firm-level carbon emissions of U.K. firms can attract more investment from institutional investors after the regulation, β_1 should be significant and negative. I report the results of Specification (3-3) in Table 3-5.

$$IO_{it} = \alpha + \beta_1(Treated_i \times After_t \times Carbon_{it}) + \beta_2(Treated_i \times After_t) + \beta_3\, Treated_i + \beta_4 After_t + \beta_5 \boldsymbol{X}_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it} \tag{3-3}$$

In this specification, IO_{it} represents the percentage of institutional ownership, measured as the total shares of firm *i* in year *t* held by all types of institutional investors. The DiDiD term is the interaction of $Treated_i$, $After_t$, and $Carbon_{it}$. Here, $Treated_i$ is a dummy variable equal to one for firms subject to the U.K. disclosure rule and zero otherwise. $After_t$ indicates the compliance year, taking the value of one from 2013 for firms with fiscal years ending on or after 30 September, and from 2014 for firms with earlier fiscal year ends. $Carbon_{it}$ captures firm-level carbon intensity, measured using total emissions intensity as well as intensity from Scope 1, Scope 2, and Scope 3 emissions. $\boldsymbol{X}_{it-1}$ is a vector of the one-year lagged firm- and investee-country level control variables, all as defined in Appendix 3-A1. The model also includes year (γ_t) and stock exchange (λ_s) fixed effects to absorb unobserved heterogeneity.

[Table 3-5 about here]

In Specification (3-3), I use four alternative measures of $Carbon_{it}$ to capture different aspects of carbon intensity: total emissions intensity, Scope 1, Scope 2, and Scope 3. The results for these measures are reported in columns (1) through (4) of Table 3-5. The dependent variable, IO_{it}, is defined as the share of institutional ownership at the firm level.

Carbon intensity is not included as a standalone regressor in Equation (3-3) because it is not exogenous in the regulatory setting examined in this study. Prior evidence from Downar et al. (2021) and Jouvenot and Krueger (2019) shows that the U.K. mandatory carbon disclosure led treated firms to reduce their emissions relative to control firms following the 2013 reform. This implies that carbon intensity is itself partially determined by the Treated × After policy shock.

The objective of the DiDiD specification is not to estimate the unconditional association between emissions and institutional ownership, but rather to identify whether institutional ownership becomes differentially sensitive to carbon intensity following the regulation for treated firms relative to appropriate counterfactual groups. Accordingly, carbon intensity enters only through the triple interaction term (Treated × After × Carbon), which captures whether the relationship between institutional ownership and carbon intensity changes for treated firms after the mandate, relative to control firms. A standalone Carbon term would primarily reflect cross-industry and cross-firm heterogeneity unrelated to the causal estimation and would risk conditioning on a post-treatment channel.

In contrast, Treated and After are included as standalone regressors because they are core components of the DiD structure. Treated captures permanent differences between U.K. and control firms, while After absorbs common time shocks affecting all firms after the regulation. Omitting these terms would impose the restrictive assumption that treated and control firms have identical baseline ownership levels and that no aggregate post-2013 shocks exist. The triple interaction (Treated × After × Carbon), therefore, measures the sensitivity of institutional ownership to carbon intensity changes following mandatory disclosure while avoiding conditioning on an endogenous policy-responsive variable. This structure is consistent with interaction-based identification frameworks in applied microeconometrics (Angrist & Pischke, 2009; Bertrand et al., 2004)

In all four model specifications, the coefficient on the DiDiD interaction term is negative and statistically significant at the 1% level. Because carbon intensity enters the regression in levels, this result indicates that, following the introduction of the U.K. mandatory carbon disclosure rule, institutional ownership became more negatively associated with carbon intensity among treated firms relative to control firms. In other words, institutional investors exhibited a stronger preference for firms with lower carbon intensity after disclosure improved transparency. Economically, the estimated coefficients imply that the sensitivity of institutional ownership to carbon intensity strengthened by 4.27 percentage points for total carbon intensity, 5.13 for Scope 1, 19.24 for Scope 2, and 7.21 for Scope 3 emissions. For example, the coefficient of −4.2724 suggests that, in the post-regulation period, a one-unit lower carbon intensity (measured in thousand tons of CO_2e per million USD of revenue) is associated with an approximately 4.27 percentage-point higher institutional ownership among treated U.K. firms relative to control firms. These findings suggest that institutional investors became more responsive to differences in firms' carbon exposure following mandatory disclosure. Overall, the results provide robust evidence that institutional investors allocate relatively more capital toward carbon-efficient firms in the post-regulatory period, supporting the carbon emissions attraction hypothesis.

The observed increase in institutional ownership among firms with lower carbon intensity, especially in the post-disclosure period, can be explained through several theoretical channels. First, from the perspective of information asymmetry, mandatory disclosure enhances the transparency and credibility of firms' environmental performance, allowing investors to more accurately assess their exposure to climate-related risks and managerial quality. By providing reliable and comparable information, disclosure reduces estimation risk and, in turn, lowers the firm's cost of capital, as investors demand smaller risk premiums for holding better-informed assets (Dhaliwal et al., 2011; Diamond & Verrecchia, 1991; El Ghoul et al., 2011; Lambert et al., 2007). Improved disclosure quality decreases uncertainty about firm value, leading to narrower bid–ask spreads, greater market liquidity, and lower required returns from investors. In addition, higher transparency increases the firm's visibility among analysts and institutional investors, broadening its investor base and further reducing the cost of both equity and debt financing. As a result, more transparent and low-emission firms become increasingly attractive to institutional investors seeking stable, well-governed, and lower-risk investment opportunities.

Second, the findings are consistent with the climate-risk pricing channel, as firms that successfully cut emissions are perceived to face lower regulatory and transition risks, making them more attractive to investors who are increasingly sensitive to climate exposures in their portfolios (Bolton & Kacperczyk, 2021a; Ilhan et al., 2023; Krueger et al., 2020). Third, from an agency theory and governance standpoint, environmental transparency allows institutional investors, especially long-term and monitoring-oriented ones, to evaluate managerial behaviour and apply effective oversight. Emission reductions thus serve as a signal of disciplined management and operational efficiency, which aligns with institutional investors' preference for firms exhibiting strong governance and responsible resource allocation (Dyck et al., 2019; Marshall et al., 2022; Starks et al., 2017). Furthermore, the long-term value creation channel highlights that emission-reducing firms often achieve greater efficiency and innovation, leading to stable cash flows, stronger competitiveness, and enhanced firm value over time (Albuquerque et al., 2019; Lins et al., 2017; Sharfman & Fernando, 2008).

Finally, from the stakeholder and legitimacy perspective, firms that actively reduce emissions strengthen their reputation and align with societal and regulatory expectations, attracting institutional investors who are increasingly guided by environmental, social, and governance (ESG) principles and reputational accountability (Gibson Brandon et al., 2022; Ioannou & Serafeim, 2017; Riedl & Smeets, 2017). Together, these channels indicate that carbon-efficient firms are rewarded with higher institutional ownership because their environmental performance signals lower information risk, reduced regulatory uncertainty, superior governance quality, and greater long-term value creation.

To mitigate potential omitted variable bias, the model includes a comprehensive set of lagged firm- and country-level control variables. The *book-to-market ratio (BM)* is negative and highly significant, suggesting that institutional investors systematically prefer to invest in growth stocks over value stocks. This is a well-documented and robust finding in financial literature, as shown by Gompers and Metrick (2001). *Stock turnover* is positive and significant, implying that higher trading activity and liquidity make shares more appealing to institutional investors (Falkenstein, 1996). Measures of financial performance, including *stock returns* and *return on assets (ROA)*, are both positive and highly significant, indicating that more profitable and better-performing firms attract greater institutional investment. This aligns with the literature showing that institutional investors favour firms with strong fundamentals and stable profitability (Doidge et al., 2007; Marshall et al., 2022). Similarly, *foreign sales* are positively and significantly associated with institutional ownership, reflecting institutional preferences for firms with international diversification and exposure to global markets, which are often seen as signals of competitiveness and reduced domestic risk (Ferreira & Matos, 2008). Conversely, firms with higher *closely held shares* exhibit significantly lower institutional ownership, consistent with the view that concentrated ownership structures deter external investors due to reduced trading opportunities and weaker corporate governance oversight (Leuz et al., 2009). Finally, country-level factors such as GDP growth and rule of law are included to control for differences in macroeconomic and institutional quality across countries. Although statistically insignificant, their inclusion helps account for variation in investment environments, consistent with evidence that institutional investors favour countries with stronger legal systems and better investor protection (La Porta et al., 1998).

Please note that Hypothesis 1 examines how institutional investors respond to firms' carbon emission levels following the introduction of mandatory disclosure. In this specification, carbon intensity is included in levels by design. The objective is not to re-estimate whether the regulation reduces emissions, as prior studies have already established this effect (e.g., Downar et al., 2021; Jouvenot & Krueger, 2019). Instead, the analysis examines how institutional investors respond to firms' carbon emission levels once disclosure improves transparency and comparability. The triple interaction term (Treated × After × Carbon) captures whether the sensitivity of institutional ownership to emission levels changes after the regulation for treated firms relative to control firms. Therefore, Hypothesis 1 focuses explicitly on emission levels as a pricing signal in the post-disclosure information environment.

In contrast, Hypotheses 2–5 do not directly include emission levels in the regression specification. Instead, these hypotheses examine whether different types of institutional investors adjust their ownership positions following the regulatory shock. The difference-in-differences framework captures the post-regulation disclosure in which treated firms are expected to improve their environmental performance relative to control firms. The analysis therefore focuses on how heterogeneous institutional investors respond to this regulatory setting.

Accordingly, references to "carbon emission reductions" in Hypotheses 2–5 refer to the broader regulatory context in which treated firms reduce emissions relative to control firms, as documented in prior studies (e.g., Downar et al., 2021; Jouvenot & Krueger, 2019). I rely on this established evidence to motivate the empirical setting and to examine whether firms that improve their carbon performance after the regulation attract institutional investment differently across investor types. The regressions in Hypotheses 2–5 do not directly estimate emission changes; rather, they analyse how institutional investors respond to the post-disclosure regulatory environment.

Thus, the interpretation differs across hypotheses. In Hypothesis 1, emission levels are intentionally included to test whether institutional ownership becomes more sensitive to carbon exposure after mandatory disclosure. In Hypotheses 2–5, the focus shifts to heterogeneous investor responses to the regulatory shock, without directly estimating the effect of emission levels. This clarification ensures that the analysis does not conflate emission levels with emission changes and that each hypothesis is interpreted consistently with its empirical specification.

3.6 Robustness tests

In this section, I conduct a series of robustness tests addressing potential concerns about model specification, sample composition, and unobserved heterogeneity. These tests are designed to verify that the observed effects of the U.K. carbon disclosure regulation on institutional ownership are not driven by coincidental trends or omitted factors. First, I conduct a pseudo-treatment test in which firms are randomly assigned to "treated" and "control" groups while maintaining the same proportion of treated firms across years. This test evaluates whether the main results arise from random variation or model specification rather than the true policy effect. Second, I re-estimate the main specification using alternative sets of fixed effects, including year, stock exchange-year, and industry-year, to account for potential time-invariant and contextual confounding factors. Third, I add additional firm-level controls, including dividend yield, plant, property and equipment (PPE), and analyst coverage, to account for payout policy, capital intensity, and the information environment that may influence institutional ownership. Finally, I perform a robustness test using alternative clustering approaches to assess whether the results are sensitive to different assumptions about the correlation structure of the residuals. Specifically, I re-cluster standard errors at the firm, industry, stock exchange and industry-year levels.

3.6.1 Placebo test

As a falsification test, I construct a pseudo-treatment by randomly assigning firms into "treated" and "control" groups while maintaining the same proportion of treated firms as in the actual sample. I then re-estimate the baseline DiDiD specification using this randomly generated treatment indicator across four different random samples. Each specification includes the full set of control variables and both year and stock-exchange fixed effects. This approach follows standard practice in DiD studies, where placebo assignments are used to identify whether estimated treatment effects could arise spuriously from model specification, sampling structure, or coincident time trends (Angrist & Pischke, 2009; Marshall et al., 2022).

[Table 3-6 about here]

The results, reported in Table 3-6, show that the coefficients of the triple-interaction term ($Treated \times After \times Carbon$) are statistically insignificant across all four random specifications. No economically meaningful relationship is detected between the pseudo-treatment and institutional ownership, even though the model specification, controls, and fixed effects are identical to those in the baseline regression. This absence of statistically significant results indicates that the main findings are not artefacts of the empirical design or random variation in the data. Instead, the estimated effects observed in the baseline analysis are specific to the true implementation of the U.K. carbon disclosure regulation and firms' carbon intensity. These placebo results reinforce the internal validity of the identification strategy and align with best-practice recommendations in quasi-experimental research that advocate falsification tests and pre-trend diagnostics to verify causal inference (Benlemlih et al., 2023; Jouvenot & Krueger, 2019).

3.6.2 Control for time-invariant confounding factors

To strengthen the credibility of the baseline findings, I re-estimate the DiDiD specification by incorporating alternative sets of fixed effects. Specifically, I include combinations of year, stock exchange, industry, stock exchange-year, and industry-year fixed effects to address potential unobserved heterogeneity across markets and sectors. This approach follows prior studies in finance and accounting that emphasise the importance of controlling for both time-invariant and time-varying confounding factors (e.g., Alexander et al., 2024; Bertrand et al., 2004; Jouvenot & Krueger, 2019). Year fixed effects capture aggregate macroeconomic shocks, stock exchange-year effects control for contemporaneous exchange-specific developments such as changes in listing standards or investor sentiment, while industry-year effects absorb sector-specific shocks such as technological shifts or regulatory adjustments (Downar et al., 2021).

[Table 3-7 about here]

The results reported in Table 3-7 remain robust to these alternative specifications. Across all models, the triple interaction term DiDiD *(Treated × After × Carbon)* is consistently negative and statistically significant at the 1% level, indicating that institutional investors allocate more capital to firms that reduce their carbon intensity following the disclosure regulation. The magnitudes of the DiDiD coefficients range from –1.94 to –3.20, which are economically meaningful and broadly comparable to the baseline estimates. Importantly, the positive and significant coefficients on the DiD term (Treated × After) confirm that treated firms experienced an overall increase in institutional ownership post-regulation, even after accounting for sectoral and exchange-level heterogeneity. These findings are consistent with the view that the observed effects are not driven by omitted contextual factors but reflect a genuine causal relationship between mandatory carbon disclosure and institutional investment behaviour (Benlemlih et al., 2023). Overall, this robustness check demonstrates that the main results are stable when additional layers of fixed effects are included. This strengthens the internal validity of the identification strategy and supports the conclusion that institutional investors respond positively to firmsin the aftermath of the U.K. disclosure regulation.

3.6.3 Additional Control Variables

To further ensure that the baseline findings are not affected by omitted variable bias, I re-estimate the main DiDiD specification by adding three additional firm-level control variables: dividend yield**,** plant, property and equipment (PPE), and analyst coverage. These variables are widely used in the finance and accounting literature to capture firm-specific characteristics that may influence institutional investment decisions. *Dividend yield* reflects firms' payout policy and financial maturity (Fama & French, 2001); *PPE* proxies for capital intensity and asset tangibility, which can affect both firm valuation and investors' risk perceptions, and *analyst coverage* serves as a measure of information transparency and market visibility that attracts institutional investors (Yu, 2008).

[Table 3-8 about here]

The results, reported in Table 3-8, show that the inclusion of these additional controls does not materially alter the main results. The triple-interaction term (*Treated* × *After* × *Carbon*) remains negative and statistically significant at the 1% level across all measures of carbon intensity (Total, Scope 1, Scope 2, and Scope 3). This indicates that even after accounting for payout policy, PPE, and analyst coverage, institutional investors continue to allocate more capital to firms that reduce carbon emissions following the U.K. disclosure regulation. In summary, the robustness check with additional controls confirms that the observed relationship between carbon disclosure and institutional ownership is not driven by omitted firm characteristics.

3.6.4 Alternative Clustering

Finally, I test the robustness of the standard-error estimates by applying alternative clustering levels, including firm, industry, stock exchange and industry-year clusters. Clustering at different dimensions helps ensure that statistical inference is not sensitive to assumptions about the correlation structure of the residuals. This practice is recommended in empirical corporate-finance research to validate the reliability of standard-error estimation when using multi-level panel data, following Jouvenot & Krueger (2019).

[Table 3-9 about here]

Table 3-9 shows that the results remain consistent across all clustering levels. The triple-interaction term DiDiD *(Treated × After × Carbon)* remains negative and statistically significant at the 1% level in all models, reaffirming the main conclusion that institutional investors allocate more capital to firms with lower carbon intensity following the disclosure regulation. These results demonstrate that the inference drawn from the baseline analysis is not sensitive to the chosen clustering dimension, providing additional evidence of the robustness of the findings.

3.7 Institutional investors' heterogeneity hypotheses testing

In this section, I test Hypotheses 2 to 5, which explore how carbon intensity relates to different categories of institutional ownership. As noted earlier, institutional investors are not uniform; their preferences toward ESG characteristics vary depending on their investment horizon, objectives, investment mandates, and constraints (Bushee, 2004; Dimson et al., 2015; Starks et al., 2017). These differences influence how distinct types of institutional investors evaluate and respond to firms' ESG performance. As outlined in Equation (3-3), the analysis thus far has aggregated institutional ownership at the level of the investee firm. While the baseline specification is suitable for testing the primary hypothesis, the analysis of institutional investor heterogeneity requires additional cross-sectional examination. To address this, four supplementary hypotheses (H_2–H_5) are developed to explore how institutional investors differ in their responses to mandatory carbon disclosure. These cross-sectional variations are identified based on several time-invariant characteristics, including investors' monitoring orientation (independent versus grey investors), investment horizon (long-term versus short-term), commitment to environmental initiatives (PRI signatories versus non-signatories), and the strength of social and environmental norms in their home countries (high-norm versus low-norm investors). This classification framework follows prior literature highlighting that investor behaviour and engagement are shaped by institutional type, investment strategy, and normative context.

3.7.1 Investor type: Investment horizon and Monitoring role

Following the literature, such as Bushee (1998) and Yan & Zhang (2009), institutional investors can be broadly categorised based on their investment horizons and trading behaviours. Table 3-A2 in the Appendix summarises these classifications, distinguishing long-term institutional investors (e.g., pension funds, insurance companies) from short-term investors such as hedge funds, which classification is based on S&P Capital IQ definitions following the study of Marshall et al. (2022). Cremers & Pareek (2016) find that long-horizon investors are more likely to engage with firms on long-term value creation and governance, whereas hedge funds tend to prioritise short-term returns through high-turnover trading strategies. Consistent with this view, Kruger (2015) documents that long-term institutional investors respond positively to firms with strong ESG practices, while short-term investors display limited sensitivity to such factors unless ESG risks become material.

Despite the growing interest in sustainable finance, it is evident that ESG-oriented investment behaviour varies substantially across investor types. Long-term institutions, often managing assets for beneficiaries over decades, are more attuned to environmental and social risks that unfold gradually. By contrast, hedge funds, with their shorter evaluation cycles and incentive fee structures, may discount long-term ESG benefits unless they offer immediate performance implications (Bolton & Kacperczyk, 2021a; Dimson et al., 2015). Avramov et al. (2022) suggests that ESG uncertainty affects the risk-return trade-off, social impact, and economic welfare, making ESG investments less attractive to short-term investors.

To this end, I examine how institutional investors with different investment horizons respond to variations in firm-level carbon performance. Specifically, I test whether long-term investors exhibit greater capital allocation toward firms with lower carbon intensity, as compared to short-term investors. To test the heterogeneity hypothesis H_2, I estimate alternative specifications of the regression equation (3-4) using the sample firms.

$$IO_{jit} = \alpha + \beta_1.(Treated_i \times After_t \times Type_j) + \beta_2(Treated_i \times After_t) + \beta_3 Treated_i + \beta_4 After_t + \beta_5 X_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it} \quad (3\text{-}4)$$

In this specification, IO_{jit} represents the proportion of shares in firm i that are owned by investor j in year t. The variables $Treated_i$ and $After_t$ are binary indicators as defined earlier. To capture differences among institutional investors, the model introduces a dummy variable, $Type_j$, which is coded in different ways depending on the hypothesis being tested. For the investment horizon hypothesis (Hypothesis 2), $Type_j$ equals one if investor j is identified as a long-term institutional investor, and zero otherwise (short-term investor). For the monitoring role hypothesis (Hypothesis 3), $Type_j$ is redefined so that it equals one when the investor is classified as an independent institutional investor, and zero when the investor belongs to the grey category. These two hypotheses are evaluated separately, each using its own model specification. The set of control variables (X_{it-1}) remains consistent with those employed in specification (3-3). To capture cross-border frictions and institutional differences that may influence the allocation of international investment, in the model (3-4), I also incorporate a set of investees–investor country-level control variables, including bilateral trade intensity, geographical distance, common language, and common border**.** These variables reflect the economic and informational linkages between the home country of the investor and the host country of the investee firm. Prior research in international finance shows that stronger economic and cultural connections facilitate cross-border investment by reducing transaction costs, information asymmetry, and home-bias preferences (e.g. Aggarwal et al., 2005; Ferreira & Matos, 2008; Grinblatt & Keloharju, 2001; Portes & Rey, 2005).

A higher level of *bilateral trade* reflects greater economic integration and familiarity between the two countries, which facilitates information exchange and reduces perceived investment risks (Ferreira & Matos, 2008; Portes & Rey, 2005). In contrast, *geographic distance* acts as a proxy for informational asymmetry and monitoring difficulty; investors are generally less likely to invest in distant firms due to higher transaction and information acquisition costs (Ferreira & Matos, 2008). Similarly, a *common language* enhances the transmission of soft information, eases the interpretation of financial disclosures, and promotes trust between market participants, thereby encouraging institutional investment (Ferreira & Matos, 2008; Guiso et al., 2009). *Common borders* further strengthen cross-border familiarity by fostering shared cultural, regulatory, and economic environments, which lower investment barriers and improve cross-country capital mobility (Guiso et al., 2009; Portes & Rey, 2005). Including these variables in the empirical specification helps control for systematic cross-country heterogeneity in investment patterns that may otherwise bias the estimated effects of firm-level disclosure or environmental performance.

The key variable of interest is the triple interaction term ($Treated_i \times After_t \times Type_j$), which serves as a Difference-in-Difference-in-Differences (DiDiD) estimator. This term is designed to test whether shifts in institutional ownership among treated firms, compared with control firms, differ systematically after the regulation, depending on the type of investor. The distinction is based on whether the investor is classified by investment horizon or by monitoring role. The outcomes of these alternative model setups are presented in Table 3-10.

Column (1) of Table 3-10 presents the estimated effects associated with the investment horizon of institutional investors. The analysis reveals that the coefficient on the triple interaction term (DiDiD) is positive and highly significant at the 1% level. These findings imply that, after the implementation of the regulation, long-term institutional investors exhibited a stronger increase in ownership of regulated firms compared with short-term investors. On average, the ownership share of long-term investors was 0.0347 percentage points higher in firms that reduced their carbon emissions relative to those in the control group, and this difference is statistically significant at the 1% level. The results support Hypothesis 2 (H_2), which posits that carbon emission reductions attract investors differently according to their investment horizons. Overall, the evidence indicates that firms reducing carbon emissions attract greater ownership from long-term institutional investors relative to short-term investors. This heterogeneity in investor response underscores that preferences toward carbon performance vary by investment horizon. These findings align with Starks et al. (2017), who document that firms with higher ESG scores tend to attract mutual funds and institutional investors with longer-term investment horizons.

[Table 3-10 about here]

To test Hypothesis 3, I examine whether independent institutional investors, characterised by business ties to investee firms, respond more positively to firms' carbon emissions reduction practice than grey institutional investors, who typically maintain closer financial or operational relationships with firms (Aggarwal et al., 2011; Chen et al., 2007). The hypothesis builds on the notion that independent investors face fewer conflicts of interest and lower monitoring costs, making them more likely to value and respond to firms' environmental performance signals, including reductions in carbon emissions. The empirical strategy employs a DiDiD specification to isolate the moderating effect of investor type on the change in institutional ownership around the U.K.'s mandatory carbon disclosure regulation, as mentioned in model (3-4) above.

Column (2) of Table 3-10 reports a positive and statistically significant DiDiD coefficient, suggesting that independent institutional investors increased their holdings in firms that reduced carbon emissions to a greater extent than grey investors after the introduction of the regulation. Specifically, the coefficient estimate of 0.0702 implies that independent investors increased their ownership in treated firms (i.e., those subject to carbon disclosure) by 0.0702 percentage points in the post-regulation period compared to grey institutional investors. These findings are consistent with Bushee (1998) and Marshall et al. (2022), who emphasise that investor type, particularly transient or grey institutions, plays a decisive role in firms' ESG responsiveness. In addition, this result reinforces prior evidence by Starks et al. (2017) and Krueger (2015), showing that ESG-committed firms are particularly attractive to investors who emphasise sustainable, long-term value and independent judgment. Control variables also exhibit expected signs. For example, firm size is negatively associated with institutional ownership, consistent with prior studies suggesting that larger or more closely monitored firms may already have their information fully reflected in market prices, leaving limited scope for additional institutional investment (Gompers & Metrick, 2001). The inclusion of firm-level controls and multiple fixed effects ensures that these results are not driven by omitted variable bias or unobserved heterogeneity across time and exchange. In summary, these findings offer robust empirical support for the heterogeneity hypothesis, Hypothesis 3 (H_3), affirming that investor heterogeneity in terms of monitoring role significantly shapes the market discipline imposed on firms pursuing environmental sustainability**.** Independent institutional investors serve as more credible monitors and responsive capital allocators when it comes to rewarding firms for improved carbon performance.

3.7.2 Climate-conscious investor: PRI signatories

To empirically test Hypothesis 4, I examine whether institutional investors that have signed the Principles for Responsible Investment (PRI) are more inclined to expand their holdings in firms that lower carbon emissions, especially after the introduction of the U.K.'s mandatory carbon disclosure regulation. This hypothesis is tested using a DiDiD approach, which is applied to the sample firms through equations (3-5).

$$IO_{jit} = \alpha + \beta_1(Treated_i \times After_t \times PRI_j) + \beta_2(Treated_i \times After_t) + \beta_3 Treated_i + \beta_4 After_t + \beta_5 X_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it} \quad (3\text{-}5)$$

In this specification, IO_{jit} represents the shareholding of firm i held by investor j in year t. The variables $Treated_i$ and $After_t$ are binary indicators as defined earlier. The variable PRI_j equals one if investor j is a signatory of the PRI, and zero otherwise. The main focus is on the triple interaction term ($Treated_i \times After_t \times PRI_j$), which captures the effect of interest. The regression outcomes from various model specifications are reported in Table 3-11. Control variables are included in line with specification (3-4), together with year and stock exchange fixed effects.

[Table 3-11 about here]

The results, reported in Table 3-11, provide strong empirical support for the hypothesis. The coefficient on the triple interaction term ($Treated_i \times After_t \times PRI_j$) is 0.1068 and statistically significant at the 1% level, indicating that PRI-signatory institutional investors increased their holdings in firms that reduced carbon emissions significantly more than their non-PRI counterparts following the regulatory mandate. These findings are consistent with the existing literature suggesting that responsible investors actively reallocate capital towards firms with improved environmental performance. Dyck et al. (2019) argue that PRI signatories exert a disproportionately larger influence on firms' E&S outcomes compared to non-signatories due to their explicit mandates and more intensive stewardship practices. Similarly, Grewal (2017) finds that ESG-prioritising institutional investors systematically outweigh environmentally proactive firms in their portfolios. The results in this study reinforce these conclusions, demonstrating that carbon emissions reduction, a core component of the “E” in ESG, is a salient signal for capital allocation decisions among PRI-aligned investors. These results offer compelling empirical validation of Hypothesis 4, confirming that PRI signatory investors differentially respond to carbon emissions reductions through increased equity ownership. The findings emphasise not only the growing role of environmental mandates in institutional portfolio management but also the catalytic role of policy intervention in unlocking ESG-aligned capital flows.

3.7.4 Climate-conscious investor: Environmental social norms country domicile

To test whether, in hypothesis 5, firm-level carbon emissions affect the investment of environmental social norms country domicile investors differently. I use social norms accounts for investor type by exploiting the Environmental Performance Index (EPI) to construct country-level norms regarding environmental issues, and classified institutional investors into two types, high and low social norms country domicile institutional investors, in line with Dyck et al. (2019). There is significant variation in social norms concerning environmental and social issues across different countries, and these differences persist over time.

I take advantage of variations in these norms among investors to examine whether environmentally conscious institutions matter when investing in firms with reductions in carbon emissions. To create country-level norms about environmental issues, I use Yale University's EPI data as a norm measure. Institutions can be categorised by their belief towards environmental ideals using this EPI. I utilise the EPI measurement by determining that institutional investors from countries with an EPI above the median will signify a country domicile institution with a high social norm, while investors from countries with an EPI below the median will indicate a country domicile institution with a low social norm. According to Dyck et al. (2019), social norms about E&S differ significantly and remain relatively constant between countries. Since investors from countries with high social norms seem to prefer stocks with better carbon performance, I hypothesise that investors from countries with high environmental social norms are more likely to invest in firms that reduce carbon emissions than investors from countries with low social norms. To test the heterogeneity hypothesis H_5, I run specifications of the regression equation (3-6) as below:

$$IO_{jit} = \alpha+\beta_1.(Treated_i \times After_t \times Norm_j) + \beta_2(Treated_i \times After_t) + \beta_3 Treated_i + \beta_4 After_t + \beta_5 X_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it} \quad (3\text{-}6)$$

where IO_{jit} represents the proportion of firm i's shares held by institutional investor j in year t. The variables $Treated_i$ and $After_t$ are indicator dummies defined as in the baseline model, identifying firms subject to the U.K. carbon disclosure regulation and the post-regulation period, respectively. The variable $Norm_j$ is an indicator equal to one if investor j is domiciled in a country with strong environmental and social norms, and zero otherwise. The coefficient of DiDiD $(Treated_i \times After_t \times Norm_j)$ is 0.0954 and statistically significant at the 1% level. I report on the regression results in Table 3-12. The positive and significant coefficient on *Treated × After × Norms* suggests that firms that reduced their carbon emissions in response to the U.K. carbon emissions disclosure attract more investment from institutional investors from high social norm countries domiciled compared to low social norm countries domiciled. This evidence suggests that institutional investors ' country of domicile matters in preferences for investing in carbon performance firms.

[Table 3-12 about here]

The positive association between firms' carbon emission reductions and the increase in institutional ownership from high social-norm countries can be explained through several interrelated theoretical mechanisms. Investors' behaviour often reflects the social and environmental values prevalent in their home countries. Institutional investors domiciled in countries with strong environmental and social norms tend to integrate these beliefs into their investment mandates and stewardship practices (Dimson et al., 2015; Dyck et al., 2019). Mandatory carbon disclosure amplifies this effect by providing reliable and comparable information, allowing investors to distinguish firms that genuinely reduce emissions from those engaging in symbolic reporting. Consequently, investors embedded in environmentally conscious societies are more likely to allocate capital to firms demonstrating credible carbon-reduction performance. This behaviour is consistent with social-norm transmission and legitimacy theories, which suggest that investors seek alignment between their investment choices and the expectations of their stakeholders, thereby maintaining reputational integrity and public legitimacy (Gibson Brandon et al., 2022; Ioannou & Serafeim, 2017; Riedl & Smeets, 2017). In addition, the findings can be understood through risk management, governance, and long-term value channels. Investors from environmentally progressive countries tend to be more aware of transition and regulatory risks associated with climate policy and therefore prefer firms that have proactively reduced emissions and improved environmental efficiency (Bolton & Kacperczyk, 2021b; Ilhan et al., 2023; Krueger et al., 2020). These firms are perceived as more resilient to future regulation and better positioned for sustainable value creation. Therefore, these mechanisms explain why institutional investors from high social-norm countries increase their ownership in emission-reducing firms after mandatory carbon disclosure; such firms simultaneously meet ethical expectations, mitigate climate risk, and offer superior long-term investment potential.

In summary, this result supports the hypothesis of carbon emission reduction attraction on heterogeneous investors, H_5. These results provide compelling evidence that the country domicile of investors plays a significant role, as expected, with institutional investors from high social norms responding more actively to firms' carbon reduction efforts following the introduction of mandatory carbon disclosure.

3.8 Conclusion

This chapter investigates how firm-level carbon intensity influences institutional ownership, focusing on whether investors with different characteristics respond differently to firms' carbon performance. Using the introduction of the U.K. mandatory carbon disclosure regulation in 2013 as a quasi-natural experiment, the analysis applies a Difference-in-Differences (DiD) framework to a large panel of European non-financial firms from 2010 to 2016. The regulation, implemented under the Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, provides an exogenous policy shock that compels firms to disclose their greenhouse gas emissions in a standardised format, thereby reducing information asymmetry and improving transparency. This setting allows for credible identification of the causal relationship between firms' carbon reduction efforts and institutional investment behaviour.

The empirical results provide strong evidence that institutional investors significantly increase their ownership in firms that achieve lower in carbon emissions following the introduction of the disclosure regulation. These results are consistent across alternative specifications and robustness tests. The findings also reveal substantial heterogeneity in investors' responses. Long-term and independent institutional investors are more likely to increase their holdings in emission-reducing firms than short-term or grey investors, highlighting the influence of investment horizon and monitoring capacity on sustainability-related investment decisions. Similarly, climate-conscious investors, particularly PRI signatories and those domiciled in countries with strong environmental and social norms, allocate more capital to firms that lower emissions, underscoring how normative and ethical factors shape portfolio choices. Together, these results confirm that both financial and non-financial motives drive institutional investors' responses to environmental performance.

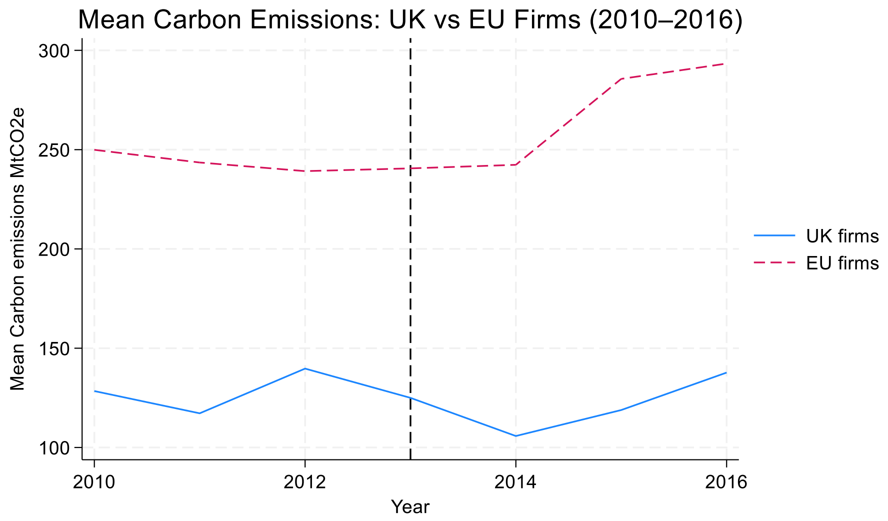
The findings support several theoretical channels. Firms that reduce emissions signal strong governance quality, enhanced transparency, and lower information risk, all of which reduce the cost of capital and attract institutional investment. Carbon-efficient firms are also perceived as less exposed to climate-related regulatory and transition risks, providing stability that aligns with the long-term investment strategies of institutional investors. Moreover, emission reductions often reflect operational efficiency and innovation, strengthening firms' competitiveness and long-term value creation. From the perspective of social and legitimacy theory, emission-reducing firms also align with societal and investor expectations, further enhancing their attractiveness to responsible and reputation-sensitive investors.

Overall, the evidence demonstrates that mandatory carbon disclosure not only enhances environmental transparency but also influences capital allocation in financial markets. Institutional investors reward firms that improve environmental performance, but the strength of their response varies with their investment horizon, monitoring role, and climate-conscious orientation. This chapter contributes to the growing literature on sustainable finance and ESG materiality by providing causal evidence that disclosure-based environmental regulation can affect investor behaviour. From a policy perspective, the results imply that well-designed disclosure requirements can effectively channel institutional capital toward climate-aligned firms, promoting transparency, accountability, and the integration of sustainability objectives into financial markets.

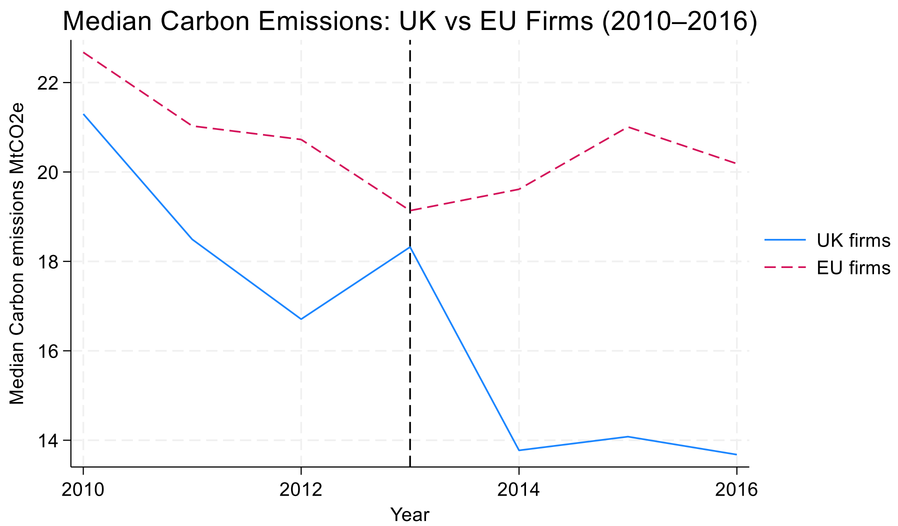
Figure of Chapter 3

Figure 3-1. Scope 1 GHG Emissions Intensity Around the Introduction of Mandatory Carbon Disclosure

This figure illustrates the evolution of firms' Scope 1 greenhouse gas (GHG) emissions intensity around the introduction of the U.K. mandatory carbon disclosure regulation in 2013. Scope 1 emissions intensity is defined as direct GHG emissions generated from firms' own operations, scaled by revenue, capturing firms' operational carbon efficiency. The treatment group consists of U.K. listed firms subject to the disclosure mandate, while the control group comprises comparable European firms not subject to the regulation. The vertical dashed line marks the regulatory implementation year.



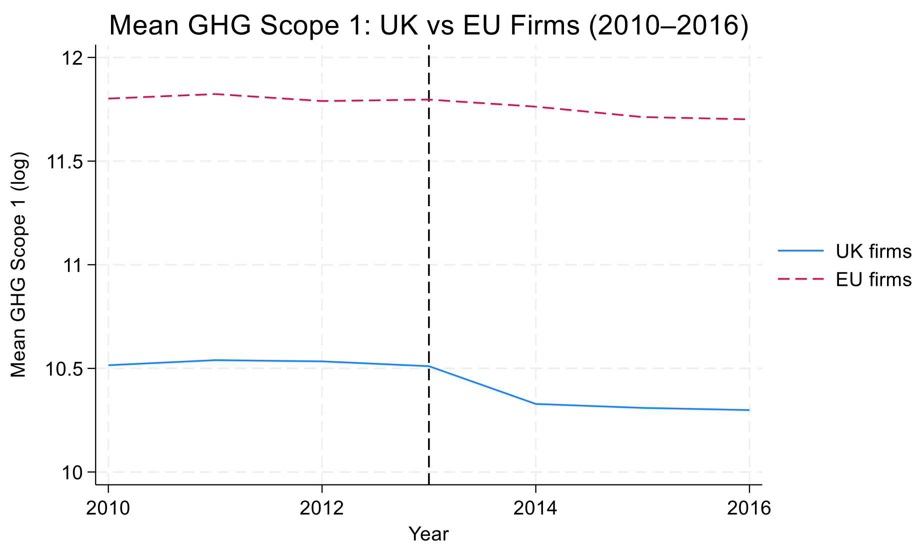
Panel A. Mean GHG Emissions Intensity Scope 1



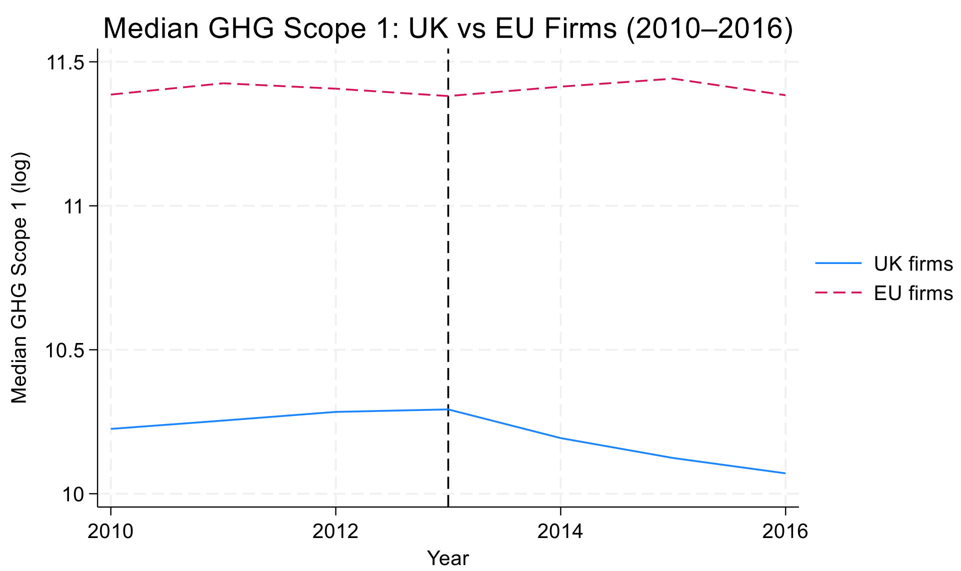
Panel B. Median GHG Emissions Intensity Scope 1

Figure 3-2. Absolute Scope 1 GHG Emissions Around the Introduction of Mandatory Carbon Disclosure

This figure illustrates the evolution of firms' absolute Scope 1 greenhouse gas (GHG) emissions around the introduction of the U.K. mandatory carbon disclosure regulation in 2013. Scope 1 emissions refer to direct emissions generated from firms' own operations and production activities. Unlike emissions intensity measures, this figure reports total emissions levels without scaling by firm revenue. The treatment group consists of U.K. listed firms subject to the disclosure mandate, while the control group comprises comparable European firms not subject to the regulation. The vertical dashed line marks the regulatory implementation year. The figure provides a descriptive assessment of pre-treatment patterns and post-regulation changes in firms' absolute environmental performance.



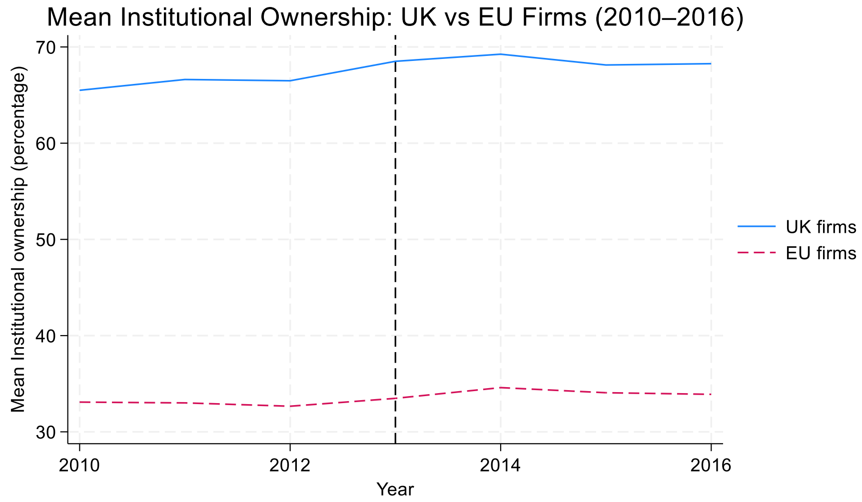
Panel A. Mean Absolute Scope 1 GHG Emissions



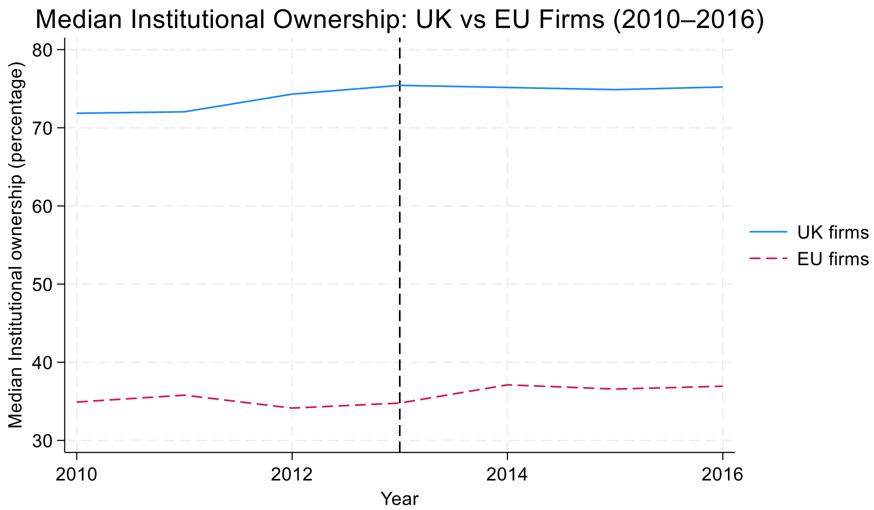
Panel B. Median Absolute Scope 1 GHG Emissions

Figure 3-3. Institutional Ownership Around the Introduction of Mandatory Carbon Disclosure

This figure illustrates the evolution of institutional ownership around the introduction of the U.K. mandatory greenhouse gas (GHG) disclosure regulation in 2013. Institutional ownership is measured as the proportion of a firm's outstanding shares held by institutional investors. The treatment group consists of U.K. listed firms subject to the disclosure mandate, while the control group comprises comparable European firms not subject to the regulation. The vertical dashed line marks the regulatory implementation year.



Panel A. Mean Institutional Ownership



Panel B. Median Institutional Ownership

Figure 3-4. Institutional ownership for U.K. (treatment) and European(control) firms around the regulation.

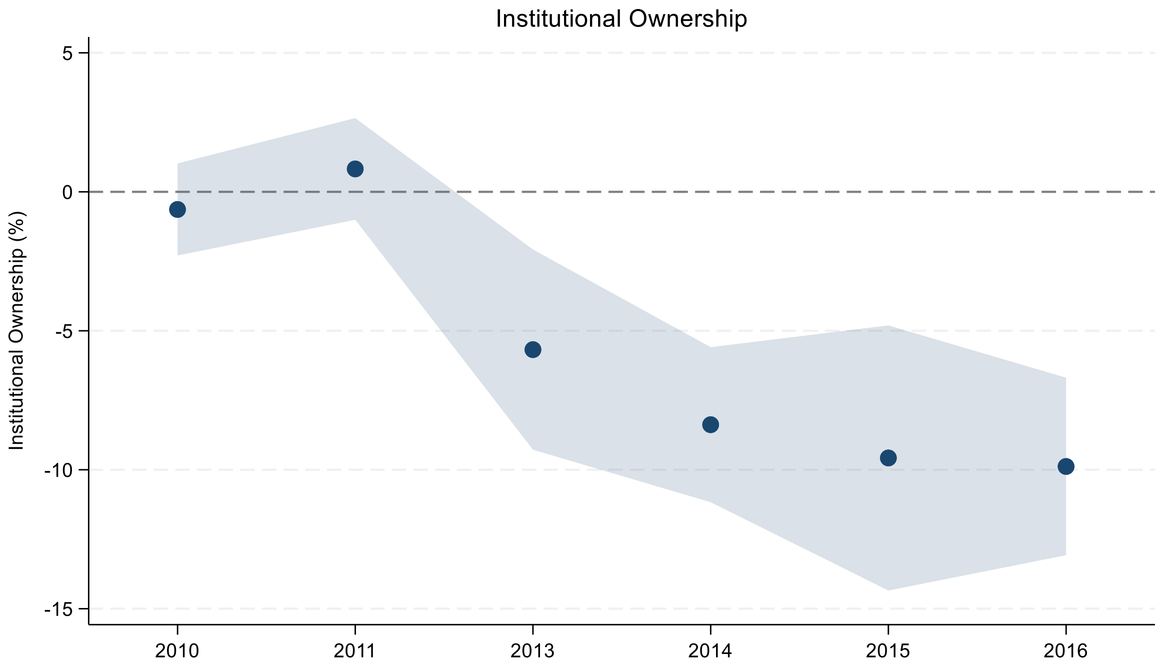


Figure 3-4 illustrates the parallel trend assumption test derived from the event-study regression. This figure presents the annual average differences in institutional ownership between U.K. and European firms, controlling for year and stock exchange fixed effects as well as other covariates. The shaded region represents the 95% confidence intervals. This pattern suggests that, prior to the enactment of the greenhouse gas (GHG) disclosure mandate, treated and control firms followed similar trajectories in institutional ownership behaviour. Hence, no significant differences in institutional ownership trends existed between the two groups before the policy change. These findings support the assumption of parallel trends, which is an important requirement for the difference-in-differences (DiD) analysis.

Tables of Chapter 3

Table 3-1 Sample selection Sample selection

Step of sample selection procedure	Firms	Firm-year
All firm-year observations for listed firms in European countries from S&P Capital IQ (2010–2016)	4,159	22,986
Exclude financial firms (SIC 6000–6999)	3,543	19,623
Exclude very small firms with market value under USD 1 million	3,411	18,997
Exclude firms with annual sale growths > 500%	2,769	15,628
Exclude firms with assets or negative revenue	2,644	15,055
Keep only firms voluntary their carbon emissions data before 2010	647	4,529

Table 3-2 Descriptive statistics

This table reports the summary statistics for all key variables used in the empirical analysis. Panel A presents greenhouse gas (GHG) emission intensities, including total emissions and Scope 1–3 components, measured in thousand metric tons of CO_2e per million U.S. dollars of revenue. Panel B provides descriptive statistics for firm-level and country-level control variables, as well as additional controls. Panel C summarises the main dependent variables, including institutional ownership (IO) and its sub-categories classified by investment horizon, monitoring role, responsible investing (PRI signatories), and domicile environmental norms. The statistics reported include the number of observations (Obs.), mean, median, standard deviation (SD), and the 10th (p10) and 90th (p90) percentiles. The sample covers firms from European countries between 2010 and 2016. To mitigate the influence of outliers, all continuous variables are winsorized at the 1st and 99th percentiles. Detailed variable definitions and data sources are provided in Appendix Table 3-A1.

Variables	Obs.	Mean	Median	SD	P10	P90
Panel A: GHG emissions intensity (in Thousand metric tons of CO2e/USD mm revenues)						
Total GHG intensity	4529	.4603	.2292	.7	.0652	1.0259
Intensity scope1	4529	.198	.0194	.563	.0023	.4871
Intensity scope2	4529	.0486	.0179	.0948	.0032	.1103
Intensity scope3	4529	.2041	.1507	.1953	.0485	.3813
Panel B: Control variables						
Firm-level control variables						
Size (in mmUSD)	4529	11450.629	3787.4607	21458.098	417.7115	29074.945
BM	4412	.6037	.4551	.5166	.1683	1.1644
Turnover	4267	.8096	.6334	.6802	.1882	1.617
Investment Opportunity	4181	6.4161	4.71	14.2741	-7.07	21.31
Return	4270	14.9782	11.67	36.5373	-25.99	57.345
ROA	4529	.0528	.0481	.0705	-.0096	.1312
Leverage	4529	.235	.2252	.1583	.0137	.4451
Closely held shares	4049	27.1295	21.11	24.3612	.62	62.34
Foreign sales	4190	.5647	.6461	.3485	0	.9736
Cash ratio	4522	.1125	.0803	.1091	.0202	.2404
Investee firm country-level control variables						
GDP growth	4522	1.8815	1.7923	1.9649	.3131	3.3231
Rule of Law	4522	1.3304	1.4155	.5028	.4834	1.7622
Investee-investor firm country-level control variables						
Bilateral trade (log)	905926	24.0337	24.3915	1.4729	21.9158	25.5477
Distance (km)	1098242	3045.3433	1438.4252	2963.2215	185.8346	6272.2852
Common language	1101743	.8807	1	.3241	0	1
Common border	1098242	.1156	0	.3197	0	1
Panel C: Main dependent variable: Institutional ownership variables						
Firm-level institutional ownership (in percentage)						
Institutional ownership (IO)	4529	42.6858	38.8252	23.6395	14.4416	79.637

Variables	Obs.	Mean	Median	SD	P10	P90
IO (Long-term)	4529	41.8387	37.9184	23.2722	14.2745	77.8021
IO (Short-term)	3719	1.0468	.152	2.1505	.0051	4.0405
IO (Grey)	4265	3.5485	3.1183	3.5723	.0203	8.1903
IO (Independent)	4529	39.4106	35.655	22.5316	12.8752	74.1531
IO (PRI)	2267	.2499	.044	.6585	.0027	.5528
IO (non-PRI)	4529	42.6277	38.72	23.829	14.3743	79.4479
IO (High norms)	4529	41.9754	38.0917	23.5515	13.8789	78.317
IO (Low norms)	3751	.5586	.1955	1.2142	.0226	1.138
Institutional-level institutional ownership (in percentage)						
Institutional ownership (IO)	1101743	.1784	.0117	.5814	.0003	.3486

Table 3-3 Pre-Regulation Descriptive Statistics for U.K. and European Firms

This table presents the descriptive statistics for key variables before the implementation of the U.K. mandatory carbon disclosure regulation. Reported statistics include the mean, standard deviation, 10th percentile (p10), median, and 90th percentile (p90), as well as the mean differences between U.K. (treatment) and European (control) firms. The table summarises greenhouse gas (GHG) emission intensities, firm-level and country-level control variables, and institutional ownership across heterogeneous investor types. The column labelled *Diff.* reports the average difference in each variable between European and U.K. firms, while the p-value column shows the statistical significance of these differences based on two-sided *t*-tests. The sample includes firms during the pre-regulation period, covering 2010 up to the U.K. firms' compliance years (2013 or 2014). All continuous variables are winsorized at the 1st and 99th percentiles to mitigate the influence of outliers. Variable definitions and data sources are provided in Appendix Table 3-A1

***Pre-regulation** Summary Statistics for U.K. and European firms*

	Treatment firms (U.K.)						Control firms (Europe)						t-statistics		
	N	Mean	Median	SD	p10	p90	N	Mean	Median	SD	p10	p90	Diff EU-UK	t-value	p-value
Panel A: GHG emissions intensity (in Thousand metric tons of CO2e/USD mm revenues)															
Total GHG intensity	584	0.3636	0.1866	0.5436	0.0658	0.7559	1453	0.4829	0.2503	0.7085	0.0674	1.0752	0.12	3.65	0.001
Intensity Scope1	584	0.1004	0.0184	0.3244	0.0038	0.2474	1453	0.2173	0.0214	0.5841	0.0026	0.5823	0.117	4.55	0
Intensity Scope2	584	0.0419	0.0204	0.073	0.0038	0.0904	1453	0.0462	0.0178	0.0892	0.0038	0.1009	0.005	1.05	0.292
Intensity Scope3	584	0.1963	0.1254	0.227	0.046	0.3662	1453	0.2143	0.1595	0.1969	0.0493	0.3922	0.018	1.8	0.074
Panel B: Control variables															
Firm-level control variables															
Size (log)	584	7.4404	7.2321	1.7192	5.3627	9.9062	1453	8.3399	8.3597	1.4784	6.4521	10.2415	0.899	11.85	0
BM (log)	565	.5212	.3857	.4509	.1408	.9987	1423	.6908	.5261	.5657	.2121	1.3073	.17	6.35	0
Turnover	564	0.6084	0.5568	0.3775	0.1914	1.0407	1349	1.0036	0.8196	0.7912	0.2081	2.0042	0.395	11.35	0
Investment Op	565	8.4525	5.8	15.0023	-6.39	24.5	1332	9.6928	7.34	15.0644	-4.45	25.95	1.24	1.65	0.101
Return	562	24.6368	18.04	39.4292	-16.4	74.55	1355	11.2072	8.67	37.4466	-32.64	56.4	-13.43	-7.05	0
ROA	584	0.0743	0.0642	0.0662	0.0151	0.1527	1453	0.053	0.0473	0.0676	-0.0049	0.1299	-0.022	-6.45	0
Leverage	584	0.1965	0.1817	0.1624	0	0.4184	1453	0.2439	0.2342	0.1556	0.0296	0.4423	0.048	6.15	0
Closely held share	533	16.7223	7.8	19.9422	0.24	49.9	1295	32.9693	30.84	24.4128	1.47	66.23	16.247	13.6	0

***Pre-regulation** Summary Statistics for U.K. and European firms*															
	Treatment firms (U.K.)						Control firms (Europe)						t-statistics		
	N	Mean	Median	SD	p10	p90	N	Mean	Median	SD	p10	p90	Diff EU-UK	t-value	p-value
Foreign sales	545	0.4533	0.4596	0.3759	0	0.9521	1331	0.593	0.6584	0.3226	0.0165	0.9735	0.14	8.1	0
Cash ratio	584	0.0969	0.0619	0.1034	0.0149	0.2154	1450	0.1186	0.0845	0.1133	0.022	0.2555	0.022	4	0
Investee firm country-level control variables															
GDP growth	584	1.6515	1.5129	0.437	1.1451	2.2387	1450	1.7101	1.683	2.4944	-0.8144	4.1799	0.059	0.55	0.573
Rule of Law	584	1.4201	1.4155	0.038	1.4155	1.4155	1450	1.3	1.5274	0.5816	0.4237	1.8075	-0.12	-5	0
Investee-investor firm country-level control variables															
Bilateral trade	93353	24.6536	25.2935	1.0981	23.2978	25.4479	299805	23.8135	24.1394	1.4848	21.7112	25.5839	-0.84	-159.8	0
Distance (km)	133487	2804.5897	959.5936	2978.0915	185.8346	5570.1611	349715	3014.9895	1438.4252	2945.8411	252.3032	6322.853	210.4	22.15	0
Common language	133670	0.9264	1	0.2611	1	1	350055	0.8663	1	0.3403	0	1	-0.06	-58.35	0
Common border	133487	0.0122	0	0.1098	0	0	349715	0.1549	0	0.3618	0	1	0.143	141.6	0
Panel C: Institutional ownership variables															
Firm-level institutional ownership (in percentage)															
IO	584	65.9248	68.8073	17.9863	39.2666	86.7695	1453	33.0805	30.567	18.501	12.2559	56.4825	-32.845	-36.5	0
IO (Long-term)	584	64.6666	68.0927	17.8787	37.5082	85.3748	1453	32.5402	29.9871	18.4057	12.1209	54.6651	-32.127	-35.9	0
IO (Short-term)	496	1.5654	0.6779	2.0466	0.0665	4.4539	1197	0.6672	0.0729	1.7223	0.0022	2.138	-0.898	-9.25	0
IO (Grey)	584	5.3265	5.0382	3.2028	1.5179	9.1121	1363	3.0156	1.614	3.7785	0.0138	8.1079	-2.311	-12.9	0
IO (Independent)	584	60.7095	63.773	17.4717	35.655	80.9034	1453	30.3254	27.5382	17.9681	10.4014	52.389	-30.384	-34.8	0
IO (PRI)	218	0.1418	0.0471	0.2969	0.0106	0.3676	630	0.1936	0.0473	0.4707	0.0016	0.4309	0.052	1.5	0.128
IO (non-PRI)	584	65.9831	68.685	18.1509	39.242	86.4811	1453	33.0708	30.567	18.8951	11.9703	56.4817	-32.912	-35.95	0
IO (High norms)	584	65.0146	67.7408	18.1788	39.1122	85.6498	1453	32.7373	30.0409	18.8455	11.8324	56.0186	-32.2775	-35.3	0
IO (Low norms)	397	.8995	.4569	1.5886	.0254	1.8171	1260	.4378	.1727	.9229	.0221	.8031	-.4615	-7.15	0

Table 3-4 Correlation matrix

This table reports the pairwise correlation coefficients among the main variables used in the empirical analysis, including measures of carbon intensity, firm-level characteristics and all types of institutional ownership. The numbers in parentheses represent the statistical significance levels (p-values) of the corresponding correlations. The sample consists of firms from European countries during the period 2010–2016. To reduce the impact of outliers, all continuous variables are winsorized at the 1st and 99th percentiles. Detailed definitions and data sources for all variables are provided in Appendix 3-A1.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
(1) Total intensity	1.00																					
(2) Size	0.00	1.00																				
	(0.92)																					
(3) BM	0.33	-0.28	1.00																			
	(0.00)	(0.00)																				
(4) Turnover	0.04	0.12	0.18	1.00																		
	(0.01)	(0.00)	(0.00)																			
(5) Sales growth	-0.05	0.00	-0.14	-0.03	1.00																	
	(0.00)	(0.77)	(0.00)	(0.06)																		
(6) Return	-0.06	0.07	-0.34	-0.04	0.17	1.00																
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)																	
(7) ROA	-0.10	0.19	-0.45	-0.16	0.23	0.23	1.00															
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)																
(8) Lev	0.04	0.09	0.10	0.12	-0.06	-0.11	-0.28	1.00														
	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)															
(9) Close	0.16	-0.08	0.15	-0.24	0.01	-0.01	-0.05	0.04	1.00													
	(0.00)	(0.00)	(0.00)	(0.00)	(0.51)	(0.35)	(0.00)	(0.01)														
(10) Foreign Sales	-0.01	0.26	-0.09	0.14	-0.01	0.01	-0.01	-0.08	-0.19	1.00												
	(0.56)	(0.00)	(0.00)	(0.00)	(0.48)	(0.52)	(0.46)	(0.00)	(0.00)													
(11) Cash ratio	-0.08	-0.07	-0.09	0.04	0.09	0.04	0.08	-0.21	0.07	0.02	1.00											
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.11)												
(12) GDP growth	0.03	0.00	-0.07	0.05	0.13	0.00	0.09	-0.05	-0.01	-0.07	0.06	1.00										
	(0.03)	(0.78)	(0.00)	(0.00)	(0.00)	(0.77)	(0.00)	(0.00)	(0.45)	(0.00)	(0.00)											
(13) Rule of law	-0.15	0.06	-0.16	0.02	-0.07	0.03	0.05	-0.15	-0.36	0.31	-0.01	-0.14	1.00									
	(0.00)	(0.00)	(0.00)	(0.26)	(0.00)	(0.07)	(0.00)	(0.00)	(0.00)	(0.00)	(0.52)	(0.00)										
(14) IO	-0.18	-0.04	-0.23	0.06	0.03	0.07	0.15	-0.10	-0.72	0.04	-0.07	0.06	0.28	1.00								
	(0.00)	(0.01)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)									

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
(15) IO_Long	-0.18	-0.03	-0.23	0.05	0.03	0.07	0.16	-0.11	-0.72	0.05	-0.07	0.06	0.27	0.99	1.00							
	(0.00)	(0.02)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)								
(16) IO_Short	-0.10	-0.17	-0.05	0.17	0.02	0.01	-0.06	0.04	-0.19	-0.08	0.02	0.04	0.10	0.33	0.24	1.00						
	(0.00)	(0.00)	(0.00)	(0.00)	(0.17)	(0.65)	(0.00)	(0.01)	(0.00)	(0.00)	(0.26)	(0.01)	(0.00)	(0.00)	(0.00)							
(17) IO_Grey	-0.08	-0.12	0.04	-0.03	-0.02	0.00	-0.05	0.02	-0.25	0.01	-0.03	-0.05	0.18	0.41	0.41	0.18	1.00					
	(0.00)	(0.00)	(0.01)	(0.07)	(0.30)	(0.88)	(0.00)	(0.11)	(0.00)	(0.42)	(0.07)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)						
(18) IO_Indep	-0.18	-0.03	-0.24	0.07	0.04	0.08	0.17	-0.11	-0.72	0.04	-0.07	0.08	0.26	0.99	0.99	0.33	0.28	1.00				
	(0.00)	(0.04)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)					
(19) IO_PRI	-0.03	-0.21	-0.04	-0.04	-0.01	-0.03	0.03	-0.04	-0.09	-0.02	-0.02	0.05	0.03	0.13	0.13	0.05	0.01	0.13	1.00			
	(0.11)	(0.00)	(0.05)	(0.06)	(0.62)	(0.17)	(0.10)	(0.05)	(0.00)	(0.48)	(0.31)	(0.03)	(0.17)	(0.00)	(0.00)	(0.02)	(0.49)	(0.00)				
(20) IO_non-PRI	-0.18	-0.04	-0.22	0.06	0.03	0.07	0.15	-0.10	-0.72	0.05	-0.07	0.06	0.27	1.00	1.00	0.33	0.41	0.99	0.10	1.00		
	(0.00)	(0.01)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)			
(21) IO_Hnorms	-0.17	-0.24	-0.18	-0.10	0.01	0.07	0.12	-0.15	-0.58	-0.01	-0.07	0.04	0.25	0.86	0.86	0.17	0.35	0.85	0.20	0.86	1.00	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.41)	(0.00)	(0.00)	(0.00)	(0.00)	(0.40)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		
(22) IO_Lnorms	-0.11	0.25	-0.18	0.23	0.04	0.03	0.12	0.00	-0.56	0.10	-0.04	0.07	0.18	0.73	0.72	0.38	0.31	0.73	-0.02	0.73	0.28	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.03)	(0.00)	(0.75)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.41)	(0.00)	(0.00)	

Note: Variables (14)–(22) represent firm-level measures of institutional ownership and its disaggregated components. (14) IO denotes total institutional ownership. (15) IO_Long and (16) IO_Short measure institutional ownership held by long-term and short-term institutional investors, respectively, classified based on investment horizon. (17) IO_Grey captures ownership by grey institutional investors, while (18) IO_Indep refers to ownership by independent institutional investors. (19) IO_PRI measures institutional ownership held by investors affiliated with the Principles for Responsible Investment (PRI), and (20) IO_NonPRI captures ownership by non-PRI institutional investors. (21) IO_Hnorms and (22) IO_Lnorms denote institutional ownership held by investors with high- and low-norms orientations, respectively. All institutional ownership variables are measured at the firm-year level.

Table 3-5 ***Carbon intensity and institutional ownership: DiDiD regression.***

This table presents the results of a DiDiD regression that examines how firms' carbon intensity influences institutional ownership following the introduction of mandatory carbon disclosure in the U.K. The estimation follows the specification below:

$$IO_{it}=\alpha + \beta_1.(Treated_i \times After_t \times Carbon_{it}) + \beta_2.(Treated_i \times After_t) + \beta_3.Treated_i + \beta_4.After_t + \beta_5.\boldsymbol{X}_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it}$$

where IO_{it} denotes institutional ownership of firm i in year t. The main variable of interest is the triple interaction between $Treated_i$, $After_t$, and $Carbon_{it}$. $Carbon_{it}$ is a proxy for carbon intensity, measured using total emissions as well as Scope 1, Scope 2, and Scope 3 emissions. $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes lagged controls. Definitions of all variables are detailed in Table 3-A1. Year (γ_t) and stock exchange (λ_s) fixed effects are included in the model. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange-year level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The analysis covers the period 2010-2016.

Dependent variable: Aggregated institutional ownership				
	(1)	(2)	(3)	(4)
DiDiD (Treated x After x Total intensity)	-4.2724***			
	(-8.0463)			
DiDiD (Treated x After x Intensity scope1)		-5.1276***		
		(-6.6104)		
DiDiD (Treated x After x Intensity scope2)			-19.2446***	
			(-3.4812)	
DiDiD (Treated x After x Intensity scope3)				-7.2050***
				(-3.9409)
DiD (Treated x After)	2.3147***	1.3190**	1.6016**	2.0846**
	(3.4365)	(2.0768)	(2.2239)	(2.4734)
Treated	11.9332***	11.9129***	11.9527***	11.8875***
	(14.5264)	(14.5647)	(14.6177)	(14.5333)
After	4.3429**	4.3451**	4.3361**	4.3679**
	(2.2731)	(2.2724)	(2.2887)	(2.2751)
Size	0.1527	0.1734	0.1558	0.1616
	(0.9933)	(1.0889)	(0.9948)	(1.0172)
BM	-2.1010***	-2.0974***	-2.1433***	-2.1335***
	(-5.0625)	(-5.0672)	(-5.1260)	(-5.0910)
Turnover	0.9673***	0.9714***	0.9803***	0.9439**
	(2.6809)	(2.6996)	(2.7124)	(2.6007)
Investment Opportunity	-0.0015	0.0008	-0.0024	0.0006
	(-0.1167)	(0.0648)	(-0.1878)	(0.0447)
Return	0.0220***	0.0223***	0.0220***	0.0232***
	(3.9052)	(3.9914)	(3.9136)	(4.2611)
ROA	15.9521***	15.4825***	16.2408***	15.9411***
	(4.7215)	(4.6568)	(4.7920)	(4.6939)
Leverage	-0.7473	-1.0043	-0.4110	-1.1667
	(-0.6022)	(-0.8120)	(-0.3238)	(-0.9381)
Closely held share	-0.4724***	-0.4738***	-0.4725***	-0.4763***

Dependent variable: Aggregated institutional ownership				
	(1)	(2)	(3)	(4)
	(-18.3994)	(-18.2678)	(-18.3007)	(-17.9919)
Foreign sale	1.5856**	1.4281**	1.6818***	1.4339**
	(2.5830)	(2.2774)	(2.7744)	(2.2546)
Cash ratio	-1.4836	-1.5015	-1.1782	-1.8779
	(-0.7826)	(-0.7869)	(-0.6404)	(-0.9567)
GDP growth	-0.1696	-0.1673	-0.1696	-0.1685
	(-0.8950)	(-0.8892)	(-0.8933)	(-0.8902)
Rule of law	1.1768	1.1335	1.2335	1.1166
	(0.8805)	(0.8495)	(0.9223)	(0.8372)
Constant	45.7918***	45.8779***	45.5167***	46.1504***
	(16.3139)	(16.3549)	(16.0117)	(16.5597)
Observations	3,291	3,291	3,291	3,291
Adjusted R-squared	0.814	0.813	0.813	0.813
Year FE	Yes	Yes	Yes	Yes
Stock Exchange FE	Yes	Yes	Yes	Yes

Table 3-6 Robustness check: Placebo test

This table presents the results of the DiDiD regression used as a placebo test to verify the robustness of the main findings. The estimation follows the specification below:

$$IO_{it}=\alpha + \beta_1 . (Treated_i \times After_t \times Carbon_{it}) + \beta_2 . (Treated_i \times After_t) + \beta_3 . Treated_i + \beta_4 . After_t + \beta_5 . \boldsymbol{X}_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it}$$

where IO_{it} represents the total institutional ownership of firm i in year t. The main coefficient of interest is the triple interaction term $(Treated_i \times After_t \times Carbon_{it})$, which captures the placebo treatment effect. $Carbon_{it}$ denotes total carbon intensity, **while $\boldsymbol{Treated_i}$ is a randomly assigned dummy variable equal to one for firms designated as "treated" and zero otherwise.** $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, and zero otherwise. The vector X_{it-1} includes lagged controls. Definitions of all variables are detailed in Table 3-A1. Year (γ_t) and stock exchange (λ_s) fixed effects are included in the model. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange-year level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The analysis covers the period 2010-2016.

Dependent variable: Aggregated institutional ownership				
	(1)	(2)	(3)	(4)
DiDiD (Treated x After x Carbon)	-0.5263	-2.4776	-0.8693	-1.2685
	(-1.6502)	(-1.4774)	(-1.1860)	(-1.5267)
DiD_Placebo test (1)	1.0582			
	(1.0353)			
Treated_Placebo test (1)	-0.8830			
	(-1.2149)			
DiD_Placebo test (2)		1.2104		
		(1.1174)		
Treated_Placebo test (2)		-0.8688		
		(-1.5727)		
DiD_Placebo test (3)			1.1674	
			(1.3723)	
Treated_Placebo test (3)			-0.9626	
			(-1.5347)	
DiD_Placebo test (4)				1.1780
				(1.4162)
Treated_Placebo test (4)				-1.1859**
				(-2.0689)
After	4.5086**	4.6497**	4.5555**	4.6276**
	(2.0820)	(2.1725)	(2.1108)	(2.1665)
Size	0.2100	0.2171	0.2082	0.2148
	(1.2578)	(1.3062)	(1.2567)	(1.2782)
BM	-2.2845***	-2.2533***	-2.2602***	-2.2885***
	(-5.7334)	(-5.6997)	(-5.7161)	(-5.7169)
Turnover	1.1834***	1.2048***	1.1543***	1.1379***
	(3.1007)	(3.1233)	(3.0150)	(2.9749)
Investor opportunity	0.0005	0.0008	0.0005	0.0005
	(0.0385)	(0.0594)	(0.0360)	(0.0346)
Return	0.0227***	0.0222***	0.0226***	0.0228***
	(4.0049)	(3.9189)	(4.0024)	(4.0329)
ROA	17.1230***	16.8499***	17.3043***	17.0858***
	(4.7123)	(4.7076)	(4.8202)	(4.7623)

Leverage	-1.7151	-1.7082	-1.6462	-1.6741
	(-1.3044)	(-1.3107)	(-1.2378)	(-1.2728)
Closely held share	-0.4791***	-0.4789***	-0.4787***	-0.4792***
	(-17.8334)	(-17.9176)	(-17.7987)	(-17.7563)
Foreign sales	0.5452	0.5741	0.5673	0.5789
	(0.7708)	(0.8226)	(0.7973)	(0.8258)
Cash ratio	-2.6721	-2.6931	-2.7967	-2.8578
	(-1.3345)	(-1.3493)	(-1.3910)	(-1.4218)
GDP growth	-0.2683	-0.2605	-0.2662	-0.2718
	(-0.9299)	(-0.9082)	(-0.9277)	(-0.9442)
Rule of law	1.6126	1.6063	1.5766	1.5267
	(1.1633)	(1.1418)	(1.1224)	(1.0966)
Observations	3,291	3,291	3,291	3,291
Adjusted R-squared	0.804	0.804	0.804	0.804
Year FE	Yes	Yes	Yes	Yes
Stock Exchange FE	Yes	Yes	Yes	Yes

Table 3-7 Robustness check: Adjusted fixed effects

This table presents the results of a DiDiD regression that examines the robustness of the main findings after adjusting for an extended set of fixed effects. The estimation follows the specification below:

$$IO_{it}=\alpha + \beta_1.(Treated_i \times After_t \times Carbon_{it}) + \beta_2.(Treated_i \times After_t) + \beta_3.Treated_i + \beta_4.After_t + \beta_5.\mathbf{X}_{it-1} + FE + \varepsilon_{it}$$

where IO_{it} represents the institutional ownership of firm i in year t. The coefficient of interest, $(Treated_i \times After_t \times Carbon_{it})$, captures the effect of carbon intensity on institutional ownership for firms subject to the U.K. carbon disclosure regulation relative to control firms. $Carbon_{it}$denotes firm-level total carbon intensity. $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes lagged controls. Definitions of all variables are detailed in Table 3-A1. FE denotes the set of fixed effects incorporated in the model, including Year, Stock Exchange, Industry, Stock Exchange-Year, and Industry-Year fixed effects represent in the model (1), (2), (3) and (4), respectively. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange-year level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The analysis covers the period 2010-2016.

Dependent variable: Aggregated institutional ownership				
	(1)	(2)	(3)	(4)
DiDiD (*Treated x After x Carbon*)	-1.9442***	-1.9974***	-3.0752***	-3.2049***
	(-2.8951)	(-2.9459)	(-4.2664)	(-4.6523)
DiD (*Treated x After*)	1.3771**	3.5116**	1.9018***	4.0035**
	(2.1202)	(2.5517)	(2.9628)	(2.3004)
Treated	10.6085***	9.3303***	10.8744***	9.6178***
	(13.8759)	(10.2849)	(13.2834)	(9.0672)
After	4.6386***	3.8759*	5.0964***	4.2554*
	(2.6714)	(1.8980)	(2.6649)	(1.6952)
Size	0.4329***	0.4523***	0.4452***	0.4779***
	(2.9159)	(2.9975)	(2.8900)	(3.1034)
BM	-1.4992***	-1.6323***	-1.5023***	-1.6919***
	(-3.2214)	(-3.3924)	(-3.1397)	(-3.4214)
Turnover	0.6727*	0.6552*	0.6421*	0.6275
	(1.8039)	(1.7632)	(1.6753)	(1.5853)
Investment Opportunity	-0.0017	-0.0010	0.0012	-0.0001
	(-0.1259)	(-0.0715)	(0.0814)	(-0.0036)
Return	0.0195***	0.0206***	0.0197***	0.0221***
	(3.1127)	(3.0124)	(2.7090)	(2.7035)
ROA	17.4162***	17.1267***	18.6303***	18.0700***
	(5.7796)	(5.4164)	(5.6578)	(5.1401)
Leverage	-0.3614	-0.0663	-0.5251	-0.5169
	(-0.2775)	(-0.0489)	(-0.3943)	(-0.3759)
Closely held share	-0.4518***	-0.4545***	-0.4569***	-0.4594***
	(-20.4328)	(-20.6222)	(-20.1579)	(-20.2258)
Foreign sales	1.7130***	1.6930**	1.8598***	1.8007***
	(2.6775)	(2.6035)	(2.8532)	(2.7869)
Cash ratio	-1.6220	-1.6118	-1.0936	-1.1816
	(-0.8167)	(-0.8004)	(-0.5355)	(-0.5777)
GDP growth	-0.1751	-0.5144	-0.1610	-0.4902

Dependent variable: Aggregated institutional ownership				
	(1)	(2)	(3)	(4)
	(-1.0436)	(-0.9854)	(-0.9129)	(-0.8825)
Rule of law	-0.2989	0.2079	-0.0692	0.2731
	(-0.2160)	(0.1179)	(-0.0492)	(0.1560)
Constant	45.1680***	45.1048***	44.3601***	44.5877***
	(16.1833)	(14.0629)	(16.2083)	(13.9686)
Observations	3,291	3,274	3,269	3,250
Year FE	Yes	Yes	Yes	Yes
Stock Exchange FE	Yes	No	Yes	No
Industry FE	Yes	Yes	No	No
Stock exchange-year FE	No	Yes	No	Yes
Industry-year FE	No	No	Yes	Yes
Adjusted R-squared	0.827	0.824	0.822	0.818

Table 3-8 Robustness check: Additional controls

This table presents the results of a DiDiD regression that assesses the robustness of the main findings by incorporating additional control variables. The estimation is based on the following specification:

$$IO_{it}=\alpha + \beta_1.(Treated_i \times After_t \times Carbon_{it}) + \beta_2.(Treated_i \times After_t) + \beta_3.Treated_i + \beta_4.After_t + \beta_5.\boldsymbol{X}_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it}$$

where IO_{it} denotes institutional ownership of firm i in year t. The primary variable of interest is the triple interaction between $Treated_i$, $After_t$, and $Carbon_{it}$. $Carbon_{it}$ is a proxy for carbon intensity, measured using total emissions and Scope 1, Scope 2, and Scope 3 emissions. $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. X_{it-1} is a vector of one-year lagged firm-level controls, including Size, BM, Turnover, Investment Opportunity, Return, ROA, Leverage, Closely held share, Foreign Sales, Cash Ratio, GDP Growth, and Rule of Law, *and additional controls*; *PPE, analyst, and dividend yield* as defined in the appendix. Year (γ_t) and stock exchange (λ_s) fixed effects are included in the model. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange-year level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The analysis covers the period 2010-2016.

Dependent variable: Aggregated institutional ownership				
	(1)	(2)	(3)	(4)
DiDiD (Treated x After x Total intensity)	-2.8798***			
	(-4.2028)			
DiDiD (Treated x After x Intensity scope1)		-3.1035***		
		(-2.9945)		
DiDiD (Treated x After x Intensity scope2)			-13.2588***	
			(-2.7402)	
DiDiD (Treated x After x Intensity scope3)				-2.8803**
				(-2.2489)
Treated	11.2406***	11.2329***	11.2614***	11.2212***
	(9.2622)	(9.2854)	(9.2972)	(9.3178)
After	3.4988**	3.5196**	3.5006**	3.5538**
	(2.3014)	(2.3115)	(2.3125)	(2.3139)
Size	1.1205***	1.1746***	1.1460***	1.2169***
	(4.5207)	(4.9512)	(4.6758)	(4.9795)
BM	-0.2496	-0.2278	-0.2480	-0.2248
	(-0.5719)	(-0.5256)	(-0.5739)	(-0.5114)
Turnover	0.3070	0.3105	0.3125	0.3017
	(0.8343)	(0.8449)	(0.8476)	(0.8157)
Investment opportunity	-0.0140	-0.0128	-0.0150	-0.0132
	(-1.0522)	(-0.9749)	(-1.1499)	(-1.0100)
Return	0.0195***	0.0195***	0.0194***	0.0198***
	(3.1855)	(3.1765)	(3.2102)	(3.2650)
ROA	7.3075**	6.9441**	7.3827**	7.0684**
	(2.0576)	(1.9869)	(2.0818)	(2.0164)
Leverage	4.9658***	4.8976***	5.3470***	4.9419***
	(4.3917)	(4.3224)	(4.7064)	(4.3249)

Dependent variable: Aggregated institutional ownership				
	(1)	(2)	(3)	(4)
Closely held share	-0.4439***	-0.4447***	-0.4431***	-0.4458***
	(-19.0802)	(-18.9631)	(-19.1320)	(-18.8251)
Foreign sales	2.8390***	2.7209***	2.9414***	2.7131***
	(4.3582)	(4.0819)	(4.6045)	(4.0128)
Cash ratio	-4.4295**	-4.5004**	-4.2672**	-4.7503***
	(-2.5309)	(-2.5579)	(-2.4889)	(-2.6839)
GDP growth	-0.2219	-0.2205	-0.2215	-0.2204
	(-1.1875)	(-1.1840)	(-1.1847)	(-1.1802)
Rule of law	1.5860	1.5478	1.6121	1.5210
	(1.2583)	(1.2291)	(1.2782)	(1.2088)
PPE	-2.0079***	-2.0415***	-2.0460***	-2.0832***
	(-11.1360)	(-11.7708)	(-11.7952)	(-11.9239)
Analyst	2.7999***	2.7843***	2.8295***	2.7636***
	(5.8072)	(5.8433)	(5.7804)	(5.8843)
Dividend yield	0.0778	0.0709	0.0842	0.0731
	(0.8187)	(0.7404)	(0.9000)	(0.7635)
Constant	42.1248***	42.1228***	41.8475***	42.1760***
	(17.0558)	(17.0217)	(16.7775)	(16.9384)
Observations	3,172	3,172	3,172	3,172
R-squared	0.8348	0.8346	0.8346	0.8342
Year FE	Yes	Yes	Yes	Yes
Stock Exchange FE	Yes	Yes	Yes	Yes

Table 3-9 Robustness check: Alternative cluster

This table presents the results of a DiDiD regression estimated using alternative clustering methods to test the robustness of the main findings. The model follows the specification below:

$$IO_{it}=\alpha + \beta_1.(Treated_i \times After_t \times Carbon_{it}) + \beta_2.(Treated_i \times After_t) + \beta_3.Treated_i + \beta_4.After_t + \beta_5 .\boldsymbol{X}_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it}$$

where IO_{it} represents the institutional ownership of firm i in year t. The coefficient of interest, $(Treated_i \times After_t \times Carbon_{it})$, captures the effect of carbon intensity on institutional ownership for firms subject to the U.K. carbon disclosure regulation relative to control firms. $Carbon_{it}$ denotes firm-level carbon intensity. $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes lagged firm-level controls. Definitions of all variables are detailed in Table 3-A1. All continuous variables are winsorized at the 1st and 99th percentiles. Year (γ_t) and stock exchange (λ_s) fixed effects are included in the model. Standard errors are clustered at firm, industry, industry-year and stock exchange levels as in models (1) to (4), respectively. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The analysis covers the period 2010-2016.

Dependent variable: Aggregated institutional ownership				
VARIABLES	(1)	(2)	(3)	(4)
DiDiD (Treated x After x Carbon)	-4.2724***	-4.2724***	-4.2724***	-4.2724***
	(-5.3841)	(-5.7959)	(-6.2288)	(-8.3203)
DiD (Treated x After)	2.3147**	2.3147**	2.3147**	2.3147***
	(2.3777)	(2.5963)	(2.5109)	(3.4223)
Treated	11.9332***	11.9332***	11.9332***	11.9332***
	(3.5878)	(4.7123)	(8.2176)	(22.9299)
After	4.3429***	4.3429***	4.3429***	4.3429*
	(3.2062)	(3.2689)	(3.2038)	(2.0364)
Standard error cluster level	*Firm*	*Industry*	*Industry-year*	*Stock exchange*
Controls	Yes	Yes	Yes	Yes
Observations	3,291	3,291	3,291	3,291
Adjusted R-squared	0.8164	0.8164	0.8164	0.8164
Year FE	Yes	Yes	Yes	Yes
Stock Exchange FE	Yes	Yes	Yes	Yes

Table 3-10 ***Investor heterogeneity: Investment horizon and Monitoring role***

This table presents the results of a DiDiD regression that examines whether the effect of the U.K. mandatory carbon disclosure regulation varies according to investor heterogeneity, focusing on both investment horizon and monitoring role. The model is estimated using the following specification:

$$IO_{jit}=\alpha + \beta_1 .(Treated_i \times After_t \times Type_j) + \beta_2 .(Treated_i \times After_t) + \beta_3 .Treated_i + \beta_4 .After_t + \beta_5 .\mathbf{X}_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it}$$

where IO_{jit} denotes the share of firm i owned by investor j in year t. The main variable of interest is the triple interaction term ($Treated_i \times After_t \times Type_j$), which captures the heterogeneous effect of the U.K. carbon disclosure regulation across different investor types. In column (1), $Type_j$ equals one if investor j is classified as a long-term institutional investor, and zero otherwise. In column (2), $Type_j$equals one if investor j is an independent institutional investor, and zero otherwise. $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes lagged controls. Definitions of all variables are detailed in Table 3-A1. Year (γ_t) and stock exchange (λ_s) fixed effects are included in the model. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange-year level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The analysis covers the period 2010-2016.

Dependent variable: Disaggregated institutional ownership		
	(1)	(2)
	Long-term institutional investors	Independent institutional investors
DiDiD (Treated x After x Long)	0.0347***	
	(3.8951)	
DiDiD (Treated x After x Independent)		0.0702***
		(12.9747)
DiD (Treated x After)	-0.0343***	-0.0611***
	(-4.1450)	(-10.7315)
Treated	-0.0217**	-0.0219**
	(-2.2311)	(-2.2499)
After	-0.0252***	-0.0253***
	(-3.8314)	(-3.8624)
Size	-0.0880***	-0.0879***
	(-26.6663)	(-26.7827)
BM	0.0058	0.0058
	(1.5189)	(1.5350)
Turnover	-0.0297***	-0.0299***
	(-8.2975)	(-8.2450)
Investor opportunity	0.0002	0.0002
	(1.5537)	(1.5291)
Return	0.0003***	0.0003***
	(6.1981)	(6.1742)
ROA	0.0702**	0.0684**
	(2.5962)	(2.5441)
Leverage	-0.0503***	-0.0505***
	(-4.8184)	(-4.8359)
Closely held share	-0.0013***	-0.0013***
	(-15.1414)	(-15.1231)

Dependent variable: Disaggregated institutional ownership		
	(1)	(2)
	Long-term institutional investors	Independent institutional investors
Foreign sale	0.0089*	0.0088*
	(1.6947)	(1.6807)
Cash ratio	0.0127	0.0131
	(0.8941)	(0.9213)
GDP growth	0.0003	0.0003
	(0.3151)	(0.2988)
Rule of law	0.0106	0.0108
	(0.7205)	(0.7339)
Bilateral trade	0.0283***	0.0283***
	(14.7697)	(14.7469)
Distance	0.0213***	0.0215***
	(7.4738)	(7.4092)
Common language	-0.0004	-0.0002
	(-0.1146)	(-0.0625)
Common border	-0.0315***	-0.0311***
	(-3.6738)	(-3.5983)
Constant	0.2061***	0.2013***
	(4.2039)	(4.1034)
Observations	546,373	546,671
Adjusted R-squared	0.0705	0.0707
Year FE	Yes	Yes
Stock Exchange FE	Yes	Yes

Table 3-11 Investor heterogeneity: PRI signatories

This table presents the results of a DiDiD regression that investigates whether the response to the U.K. mandatory carbon disclosure regulation differs between PRI signatory and non-signatory institutional investors. The estimation follows the specification below:

$$IO_{jit} = \alpha + \beta_1 . (Treated_i \times After_t \times PRI_j) + \beta_2 . (Treated_i \times After_t) + \beta_3 . Treated_i + \beta_4 . After_t + \beta_5 . \boldsymbol{X}_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it}$$

where IO_{jit} denotes the proportion of firm i's shares held by investor j in year t. The main coefficient of interest is the triple interaction term $(Treated_i \times After_t \times PRI_j)$, which captures the differential effect of the U.K. carbon disclosure regulation for investors that are signatories of the Principles for Responsible Investment (PRI). PRI_j is a binary variable equal to one if investor j is a PRI signatory and zero otherwise. $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. Definitions of all variables are detailed in Table 3-A1. Year (γ_t) and stock exchange (λ_s) fixed effects are included in the model. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange-year level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The analysis covers the period 2010-2016.

Dependent variable: Disaggregated institutional ownership	(1) PRI-signatory institutional investors
DiDiD (Treated x After x PRI)	0.1068*** (59.5816)
DiD (Treated x After)	0.0069* (1.7473)
Treated	0.0030 (0.6283)
After	-0.0122* (-1.8855)
Size	-0.0928*** (-9.0577)
BM	0.0099** (2.1637)
Turnover	-0.0427*** (-4.7652)
Investor opportunity	-0.0001 (-0.9153)
Return	0.0002*** (5.2678)
ROA	0.0350 (0.8336)
Leverage	-0.0482** (-2.7218)
Closely held share	-0.0016*** (-10.4054)
Foreign sales	-0.0026 (-0.3623)
Cash ratio	-0.0047 (-0.1825)

Dependent variable: Disaggregated institutional ownership	
	(1) PRI-signatory institutional investors
GDP growth	-0.0003
	(-0.3187)
Rule of law	0.0122
	(0.6094)
Common language	0.0599*
	(2.0403)
Common border	-0.0617***
	(-5.3204)
Constant	1.0642***
	(10.9148)
Observations	813,020
Adjusted R-squared	0.0756
Year FE	Yes
Stock Exchange FE	Yes

Table 3-12 Investor heterogeneity: Environmental - social norms country domicile

This table presents the results of a DiDiD regression study on whether investors' responses to the U.K. mandatory carbon disclosure regulation vary depending on the environmental and social norms of their home countries. The model is estimated using the following specification:

$$IO_{jit} = \alpha + \beta_1.\ (Treated_i \times After_t \times Norm_j) + \beta_2.\ (Treated_i \times After_t) + \beta_3.\ Treated_i + \beta_4.\ After_t + \beta_5\ .\boldsymbol{X}_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it}$$

where IO_{jit} represents the proportion of firm $i's$ shares held by investor j in year t. The key coefficient of interest, $(Treated_i \times After_t \times Norm_j)$, captures the heterogeneous effect of the U.K. carbon disclosure regulation based on the environmental and social norms of the investor's home country. $Norm_j$ is a binary variable equal to one if investor j is domiciled in a high environmental social-norm country, and zero otherwise. $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes lagged controls. Definitions of all variables are detailed in Table 3-A1. Year (γ_t) and stock exchange (λ_s) fixed effects are included in the model. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange-year level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The analysis covers the period 2010-2016.

Dependent variable: Disaggregated institutional ownership	
	(1) Environmental-social norm countries domicile
DiDiD (Treated x After x Norm)	0.0954***
	(13.7163)
DiD (Treated x After)	-0.0868***
	(-11.4042)
Treated	0.0028
	(0.5114)
After	-0.0104
	(-1.4438)
Size	-0.0927***
	(-23.4859)
BM	0.0102***
	(2.9827)
Turnover	-0.0425***
	(-9.4280)
Investment Opportunity	-0.0001
	(-0.8185)
Return	0.0002***
	(3.1054)
ROA	0.0367
	(1.4570)
Lev	-0.0469***

Dependent variable: Disaggregated institutional ownership	
	(1)
	Environmental-social norm countries domicile
	(-4.4695)
Closely held share	-0.0016***
	(-15.7571)
Foreign sales	-0.0018
	(-0.3836)
Cash ratio	-0.0042
	(-0.2758)
GDP growth	-0.0003
	(-0.5206)
Rule of law	0.0126
	(1.3454)
Common language	0.0591***
	(5.3969)
Common border	-0.0616***
	(-13.6733)
Constant	1.0615***
	(26.3476)
Observations	808,899
Adjusted R-squared	0.0754
Year FE	Yes
Stock Exchange FE	Yes

Appendix to Chapter 3

Table 3-A1: Variable Definition

Variable	Description	Data source
Institutional ownership variables		
IO_{it}	The total percentage of a firm's outstanding shares held by institutional investors for firm i in year t.	S&P Capital IQ
IO_{jit}	The percentage of shares in firm i held by institutional investors of type j (e.g., long-term, short-term, independent, or PRI signatories) in year t.	S&P Capital IQ
Carbon intensity variables		
Total carbon intensity	Calculated as the ratio of a firm's total greenhouse gas (GHG) emissions (measured in thousand tonnes of CO_2 equivalent, tCO_2e) to total revenues (measured in million U.S. dollars).	Truecost
Carbon intensity scope 1	Calculated as the ratio of direct GHG emissions (Scope 1), measured in thousand tonnes of CO_2 equivalent (tCO_2e), to total revenues (in million U.S. dollars).	Truecost
Carbon intensity scope2	Calculated as the ratio of direct GHG emissions (Scope 2), measured in thousand tonnes of CO_2 equivalent (tCO_2e), to total revenues (in million U.S. dollars).	Truecost
Carbon intensity scope3	Calculated as the ratio of direct GHG emissions (Scope 3), measured in thousand tonnes of CO_2 equivalent (tCO_2e), to total revenues (in million U.S. dollars).	Truecost
Key DiD and IV variables		
$Treat_i$	An indicator variable that equals one for firms subject to the U.K. mandatory carbon disclosure regulation introduced under the Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, and zero otherwise.	Derived from the London Stock Exchange website
$After_t$	An indicator variable representing the post-regulation period. It equals one from 2013 for firms whose fiscal year ends on or after 30 September, and one from 2014 for firms whose fiscal year ends before 30 September, following the classification used by Jouvenot and Krueger (2019).	Derived from S&P Capital IQ
Carbon	Denotes the carbon intensity of firm i at the end of year t, measured as the ratio of total greenhouse gas (GHG) emissions (in thousand tonnes of CO_2 equivalent, tCO_2e) to total revenue (in million USD).	Derived from Truecost
Control variables		
Firm-level control variables		
Size	The natural logarithm of a firm's annual market capitalisation is measured in millions of U.S. dollars.	Derived from S&P Capital IQ
BM	The natural logarithm of the ratio of book value per share to the year-end market share price.	Derived from S&P Capital IQ
Analyst	The number of financial analysts covering a given firm in year t.	S&P Capital IQ
PPE	The natural logarithm of total property, plant, and equipment is expressed in millions of U.S. dollars.	S&P Capital IQ
Turnover	The annual trading volume is divided by the outstanding adjusted shares.	S&P Capital IQ
Investment Opportunity	The annual growth rate of net sales is measured in U.S. dollars.	Refinitiv

Variable	Description	Data source
Return	The firm's annual geometric stock return (end-of-year)	Refinitiv
ROA	The ratio of net income to total assets (book value)	Derived from S&P Capital IQ
Leverage	The ratio of total debt to total assets	S&P Capital IQ
Closely held share	The proportion of shares held by insiders, large blockholders, or affiliated investors relative to total shares outstanding.	Refinitiv
Foreign sales	The proportion of international net sales to total net sales	Refinitiv
Cash ratio	The ratio of cash and short-term investments to total assets	S&P Capital IQ
Investee firm country-level control variables		
GDP growth	The annual percentage change in real gross domestic product (GDP) per capita for each country.	Worldwide Governance Indicators data (WORLD BANK)
Rule of Law	The Rule of Law Index is a state's score based on the absence of corruption, open government, fundamental rights, order and security, regulatory enforcement, civil justice, and criminal justice.	The World Justice Project (the Global Economy website)
Investee-investor bilateral control variables		
Bilateral trade	The logarithm value of the paired country's total export and import values.	Derived from International Trade (CEPII)
Distance	The natural logarithm of the bilateral geographical distance (in kilometres) between a country's capital city and the capital city of another country.	CEPII
Common language	Common language dummy which takes the value of one if a pair of countries shares a common language	CEPII
Common border	A common language dummy which takes the value of one if a pair of countries shares a border, and zero otherwise.	CEPII
Other indicator dummy variables		
Type of institutional investors		
Long	An indicator variable equal to one if investor j is classified as a long-term institutional investor, and zero otherwise.	S&P Capital IQ
Independent	An indicator variable equal to one if investor j is an independent institutional investor and zero otherwise.	S&P Capital IQ
PRI	An indicator variable equal to one if investor j is a signatory of the United Nations Principles for Responsible Investment (PRI), and zero otherwise.	PRI website
Norm	An indicator variable equal to one if investor j is domiciled in a country with strong environmental and social norms, and zero otherwise.	Constructed

Table 3-A2 Institutional investors type with classification based on S&P Capital IQ definitions

Monitoring role of institutional investors	
Independent Investors	**Grey Investors**
Corporate Pension Plan Sponsor	Bank/Investment Bank
Government Pension Plan Sponsor	Endowment Fund Sponsor
Hedge Fund Manager/CTA	Family Office/Family Trust
REIT/Real Estate Investment Manager	Foundation Fund Sponsor
Traditional Investment Manager	Insurance Company
Union Pension Plan Sponsor	Sovereign Wealth Fund
	Unclassified
	VC/PE Firm

Investment Horizon	
Long-term Investors	**Short-term Investors**
Bank/Investment Bank	Hedge Fund Manager/CTA
Corporate Pension Plan Sponsor	
Endowment Fund Sponsor	
Family Office/Family Trust	
Foundation Fund Sponsor	
Government Pension Plan Sponsor	
Insurance Company	
REIT/Real Estate Investment Manager	
Sovereign Wealth Fund	
Traditional Investment Manager	
Union Pension Plan Sponsor	
VC/PE Firm	

Table 3-A3 ***Carbon intensity and institutional ownership: OLS regression***

This table presents the results of the Ordinary Least Squares (OLS) regression that examines the association between carbon intensity and institutional ownership. The estimation is based on the following specification:

$$IO_{it}=\alpha + \beta_1.Carbon_{it} + \beta_2.\boldsymbol{X}_{it-1} + \gamma_t + \lambda_s + \varepsilon_{it}$$

where IO_{it} is the institutional ownership of firm *i* for the year *t*. Carbon_{it} serves as a proxy variable that includes overall carbon intensity together with intensities from Scope 1, Scope 2, and Scope 3 emissions and total carbon intensity, respectively. X_{it-1} is a vector of the one-year lagged controls. All variable definitions are defined in the appendix. γ_t and λ_s are the year and stock exchange fixed effects, respectively. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are applied. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The analysis covers the period 2010-2016.

Variables	(1)	(2)	(3)	(4)
Intensity Scope1	-0.0016**			
	(-2.4118)			
Intensity Scope2		-0.0132***		
		(-3.2565)		
Intensity Scope3			-0.0030*	
			(-1.8340)	
Total intensity				-0.0016**
				(-2.6751)
Size	0.3183	0.2003	0.2323	0.3051
	-1.3049	-0.867	-1.0152	-1.3118
BM	-1.7565**	-2.0411***	-2.1220***	-1.6723**
	(-2.3972)	(-3.1456)	(-3.1117)	(-2.3263)
Turnover	1.2324*	1.2486*	1.2030*	1.2529*
	-1.9559	-2.0127	-1.9768	-1.9976
Investment Opportunity	-0.0028	-0.0054	-0.0024	-0.0045
	(-0.1701)	(-0.3108)	(-0.1418)	(-0.2631)
Return	0.0213***	0.0218***	0.0230***	0.0213***
	-5.5864	-5.8344	-6.7059	-5.5917
ROA	16.7192***	16.9443***	16.8835***	16.7941***
	-3.3099	-3.2969	-3.3271	-3.249
Leverage	-1.5987	-0.2851	-1.8476	-1.5278
	(-0.9340)	(-0.1873)	(-1.0597)	(-0.9198)
Closely held share	-0.4701***	-0.4712***	-0.4739***	-0.4689***
	(-7.4358)	(-7.6604)	(-7.2982)	(-7.5119)
Foreign sales	0.785	1.4864	1.1116	1.0347
	-0.7167	-1.5838	-0.9447	-0.9754
Cash ratio	-2.4809	-1.937	-2.8268	-2.8592
	(-1.2627)	(-0.9998)	(-1.3035)	(-1.4355)
GDP growth	-0.1749	-0.171	-0.1652	-0.1757
	(-0.7646)	(-0.7014)	(-0.7120)	(-0.7469)
Rule of Law	7.3418	7.2143	7.6917	7.5062
	-1.2996	-1.3118	-1.2914	-1.3224
Observations	3,291	3,291	3,291	3,291
Adjusted R-squared	0.8075	0.8089	0.8069	0.8083
Year FE	Yes	Yes	Yes	Yes
Stock Exchange FE	Yes	Yes	Yes	Yes

Table 3-A4 Parallel Trend Assumption – the Effect of the Mandatory carbon disclosure on Institutional Ownership

This table presents the **DiD** estimates used to test the **parallel trend assumption**, examining whether the introduction of *The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013* affected institutional ownership. The analysis explores ownership dynamics for **three years before and three years after** the implementation of the regulation. The dependent variable is the **percentage of institutional ownership**. *Treated* is an indicator dummy variable that takes the value of one for firms that are affected by the U.K. Year = t are year dummies. *Treated × Year = t* are interaction terms between the treatment dummy and the respective year dummies. All continuous variables are winsorized at the 1st and 99th percentiles. Robust standard errors are applied. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The analysis covers the period 2010-2016.

	(1)
Treated × Year = 2010	-0.6344
	(-1.0850)
Treated × Year = 2011	0.8240
	(1.2754)
Treated × Year = 2012	0.0000
	(.)
Treated × Year = 2013	-5.6767***
	(-4.4622)
Treated × Year = 2014	-8.3780***
	(-8.5032)
Treated × Year = 2015	-9.5746***
	(-5.6837)
Treated × Year = 2016	-9.8808***
	(-8.7616)
DiD (Treated × After)	8.9581***
	(33.5243)
Controls	Yes
FE	Yes
Observations	3,291
R-squared	0.8024

Chapter 4: Mandatory Carbon Disclosure and Dividend Policy

4.1 Introduction

Carbon disclosure has shifted from a voluntary initiative to a legal requirement across many jurisdictions. Nations such as the U.K., members of the European Union, Australia, Turkey, and Brazil now require large or publicly listed companies to report their greenhouse gas (GHG) emissions using standardised reporting frameworks. China is also expected to introduce similar mandatory reporting requirements by 2027. The United Kingdom's 2013 mandate is one of the earliest examples of mandatory carbon disclosure. More recent frameworks, such as the European Union's Corporate Sustainability Reporting Directive (CSRD) and California's Climate Corporate Data Accountability Act (SB 253), demonstrate how disclosure requirements are now integrated into financial and regulatory systems around the world. These policies aim to improve transparency, reduce information asymmetry, and make cross-firm comparisons easier for investors and regulators (Downar et al., 2021; Jouvenot & Krueger, 2019). While mandatory emissions disclosure has clear benefits in reducing information asymmetry and enhancing comparability, it's crucial to also consider the potential impacts of implementing these programs on firm behaviour and economic outcomes.

A growing body of research examines how mandatory environmental disclosure affects firms' real activities and financial outcomes. Evidence indicates that required disclosure often leads firms to reduce greenhouse gas emissions and enhance environmental practices (Jouvenot & Krueger, 2019), and that they experience improved stock liquidity (Krueger et al., 2021) and greater profitability (Downar et al., 2021). Broader empirical studies further show that such disclosure mandates are associated with lower stock return uncertainty (Bolton & Kacperczyk, 2021a), higher market valuation (Wang, 2023), and generally no significant impact on gross margins (Downar et al., 2021). However, the effects of environmental practice on payout policy are unclear, some studies find that firms retain more cash to support environmental investments, while others suggest that enhanced monitoring and reduced agency frictions enable higher dividends (e.g. Bonaimé, 2015; Chang et al., 2024; Downar et al., 2021; Fonseka & Richardson, 2023; Zhu & Hou, 2022). This uncertainty motivates a focused examination of how carbon disclosure mandates affect dividends. In this chapter, I extend the existing literature by investigating how the implementation of a unique mandatory carbon disclosure policy influences dividend payouts, which are central to shareholder returns.

In response to mandatory carbon disclosure reporting, firms may opt to either increase or decrease their dividend payouts. Under agency theory, monitoring and transparency reduce the scope for managers to hoard free cash flow, pushing firms toward higher payouts (Jensen, 1986). Under signalling theory, managers may raise dividends to credibly signal stability when scrutiny rises (Baker & Wurgler, 2004; Miller & Rock, 1985). However, under the pecking-order view, firms facing new investment needs or higher uncertainty will conserve internal funds rather than distribute them (Myers & Majluf, 1984). Carbon disclosure can therefore pull dividends in opposite directions, either up via monitoring and signalling, or down via precaution and financing needs.

Two theoretical mechanisms provide reasons to expect lower dividend payouts after the introduction of the mandate. First, disclosure can reveal shortfalls in environmental performance and increase pressure to invest in abatement, process changes, and green innovation. When firms use retained earnings to finance these expenditures, their ability to pay dividends decreases. This outcome is consistent with both the pecking order theory and precautionary motives. According to Grewal et al. (2019), required ESG reporting is likely to expose sensitive corporate information that can be utilised by various stakeholders, including governments, socially responsible investors, and lenders, to push firms into increasing their ESG investments. In the event that these disclosures compel firms to enhance their non-financial practice, they may need to procure additional funding to facilitate such improvements. One potential method for financing such investments is through the use of retained earnings (Gibbons, 2020). Consequently, it is conceivable that the typical dividend might decrease as a cost-saving strategy for future expenses, considering that firms anticipate facing heightened pressure to improve their sustainability practices (Chen et al., 2024). Second, stricter reporting can raise perceived regulatory and reputational risk, widen the distribution of future cash flows and encourage buffer cash retention rather than distributions. Both channels point to a reduction in dividends when non-financial obligations become more salient.

However, opposing mechanisms suggest that mandatory disclosure could instead lead to higher dividends. First, standardised public reporting improves investor monitoring and reduces information asymmetry (Hail et al., 2014; Harakeh, 2020; Nagar & Schoenfeld, 2021). This limits managerial discretion and strengthens the use of dividends as an external governance tool (Jensen, 1986; La Porta et al., 1998). As a result, firms may increase dividend payments following mandatory carbon disclosure to reassure investors and signal their commitment to shareholder value, particularly under growing stakeholder pressure (Baker & Wurgler, 2004; Grewal et al., 2019). Evidence also shows that mandatory non-financial disclosure attracts long-term institutional investors, which can constrain arbitrary dividend cuts (Gibbons, 2020). Second, disclosure can intensify stakeholder demands. To address concerns that resources might be diverted to non-value-adding projects, managers may raise dividends as a signal of their focus on shareholder value (Baker & Wurgler, 2004; Hail et al., 2014). Evidence from China supports a positive link between mandatory ESG reporting and dividend increases due to enhanced shareholder monitoring (Fonseka & Richardson, 2023). Together, these mechanisms suggest that, following a mandate, firms, particularly those with attentive owners, may increase dividend payouts.

These competing views lead to two testable hypotheses. H1a (financing/precaution channel): dividends decline after mandatory carbon disclosure. H1b (monitoring/signalling channel): dividends rise after mandatory carbon disclosure. Which effect dominates is ultimately empirical and likely to vary with ownership structure and environmental exposure. This chapter specifically explores whether the introduction of mandatory carbon disclosure requirements affects firms' dividend policies, drawing on the U.K. Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013 as a quasi-natural experiment. I compare U.K. firms listed on the Main Market subject to the mandate (treatment firms) with otherwise similar European firms (control firms) not covered by the rule, before and after the policy. For the empirical analysis, I use a difference-in-differences (DID) framework. This approach is well-suited because the introduction of the disclosure rule can be treated as an external policy change, independent of firms' dividend decisions. In this way, the regulation serves as a quasi-natural experiment that allows me to compare how firms subject to the mandate adjusted their payouts relative to similar firms that were not affected. In this chapter, the sample comprises 16,542 firm-year observations across European countries from 2009–2017, which provides power and variation for identification.

The main finding is straightforward and shows that dividends increase after the mandate. U.K. firms affected by the rule raise their payouts by about 8.69% compared with the sample U.K. average, which is approximately USD 22.48 million increase in dividend payments. The findings remain consistent across alternative measures of dividend payouts. When dividends are scaled by either earnings or sales, similar increases are observed, confirming the robustness of the results. The conclusions also hold under various robustness checks, including placebo tests, alternative payout definitions, and the inclusion of additional control variables. Evidence from share repurchases further indicates that the results are not driven by substitution between payout channels. Together, these outcomes provide strong support for the hypothesis that mandatory carbon disclosure affects firms' dividend policies. Importantly, the validation of the parallel trend assumption reinforces the credibility of the difference-in-differences identification strategy.

This study connects to several strands of existing research. The first is the literature that examines how CSR and ESG practices influence firms' dividend policies (Fonseka & Richardson, 2023; Liu et al., 2024). These findings highlight the important boundary condition of agency problems and monitoring power in determining the effects of mandatory carbon disclosure on dividend policy. Next, I provide evidence that the dividend response is particularly strong in settings with specific characteristics such as institutional ownership. Institutional investors are widely recognised as effective monitors who can reduce information asymmetry, discipline managerial discretion, and shape payout decisions (Aggarwal et al., 2011; Shleifer & Vishny, 1986; Short et al., 2002). When disclosure requirements increase transparency, institutions gain stronger tools to evaluate firm behaviour and press managers to return excess cash to shareholders. In this way, disclosure and institutional monitoring may reinforce each other to produce higher dividend payouts. To test this mechanism, I examine whether institutional investors amplify the mandate's effect using a triple-differences design (DiDiD) that interacts treatment with firm-level institutional ownership. The results show that the dividend response is stronger when institutional ownership is higher, consistent with institutions' comparative advantage in information processing and monitoring. In such settings, disclosure and governance work together to translate transparency into higher payouts.

The role of institutional ownership is further nuanced by investment horizons. Long-term investors, e.g. Government Pension Plan Sponsor and Traditional Investment Manager[13], they favour stable dividend commitments and are better positioned to monitor managers (Bushee, 1998; Chen et al., 2007; Gaspar et al., 2005). By contrast, transient investors often prioritise short-term flexibility, making them less likely to support sustained increases in payouts. Consistent with agency theory (Jensen, 1986), the presence of long-term institutions may therefore strengthen the disciplining role of dividends by reducing managerial scope to hoard cash. From a signalling perspective (Miller & Rock, 1985), firms with high institutional oversight may also find dividend increases a credible way to demonstrate financial soundness and commitment to shareholder value. Consistent with these arguments, I further examine whether the treatment effect varies with investor horizons. Using the double difference-in-differences approach, the evidence shows that the positive effect of mandatory disclosure on dividends is concentrated in firms with long-term institutional ownership, while short-term ownership does not reinforce the dividend increase. This heterogeneity strengthens the case for a monitoring-based mechanism and highlights the role of ownership structure in shaping how disclosure regulations influence payout policy.

Another important mechanism is the firm's level of carbon emissions. Prior research shows that carbon-intensive firms face higher regulatory scrutiny, reputational risks, and financing constraints than their low-emission peers (Bolton & Kacperczyk, 2021a; Ilhan et al., 2021). These pressures can directly affect dividend policy. On the one hand, mandatory disclosure improves transparency and strengthens monitoring, creating incentives for managers to use dividends as a governance tool or as a signal of financial strength (Benlemlih, 2019; Miller & Rock, 1985). On the other hand, high-emission firms often face significant compliance costs, transition risks, and reputational concerns, which limit their ability to

[13] In this thesis, the classification of investment horizons follows the definitions provided by S&P Capital IQ.

increase payouts (Aghion et al., 2016; Cheng et al., 2014; Flammer et al., 2021). By contrast, low-emission firms are less financially constrained and can respond more strongly to disclosure by raising dividends to reassure investors and highlight their environmental advantage. Overall, these arguments suggest that firms' emissions levels condition the effect of mandatory carbon disclosure on dividend policy. To empirically validate this mechanism, I further test whether the effect varies with carbon emissions levels. The results show that firms with lower emissions show a more pronounced increase in dividends, which is intuitive; these firms face fewer immediate abatement costs and litigation risks, leaving more room to use dividends for signalling and governance. By contrast, high-emission firms confront tighter real constraints that can temper payout growth.

My study contributes to the literature in three ways. First, I contribute to the broader literature on how non-financial disclosure influences dividend policy, including studies on mandatory CSR and ESG reporting (Balachandran & Nguyen, 2018; Chen et al., 2024; Fonseka & Richardson, 2023; Ni & Zhang, 2019). I extend this line of work by focusing specifically on mandatory environmental disclosure, using the case of mandatory carbon reporting. This regulation is exogenous to firms and requires all firms to disclose greenhouse gas emissions in a standardised format. The U.K. setting is particularly valuable because it represents one of the first large-scale mandatory carbon disclosure regimes, offering new insights into how transparency and regulatory pressure shape corporate financial decisions. By reducing uncertainty and providing clearer information to investors, the U.K. regime may also stabilise or even increase dividend payouts.

Second, I contribute to the broader literature on mandatory carbon disclosure. An increasing number of studies on mandatory carbon disclosure, with the aim of mapping and understanding its impacts[14]. Several papers demonstrate the impact of such a mandate on several aspects, such as the cost of capital (Bolton & Kacperczyk, 2021a); financial operating performance (Baboukardos, 2017; Bobae Choi & Le Luo, 2021; Krueger, 2015); the firm's carbon emissions level (Jouvenot & Krueger, 2019). I extend the discussion by examining the impact of mandatory carbon disclosure on a firm's dividend policy using a sample of firms in European countries. To the best of my knowledge, this is the first study to link mandatory carbon disclosure to dividend policy.

Third, I examine the mechanisms through which disclosures lead to higher payouts by analysing key intermediate factors. Using triple-differences designs, I document that the dividend response is stronger (i) when institutional ownership is higher, consistent with institutions' monitoring advantages (Aggarwal et al., 2011; Chen et al., 2007; Shleifer & Vishny, 1986) (ii) when ownership is long-horizon rather than transient, in line with agency and signalling views that sustained monitoring supports stable payout commitments (Bushee, 1998; La Porta et al., 2000; Miller & Rock, 1985); and (iii) when carbon emissions are lower, reflecting fewer compliance and transition constraints and thus greater capacity to fund dividends (Aghion et al., 2016; Bolton & Kacperczyk, 2021a; Cheng et al., 2014; Ilhan et al., 2021). I also show that buybacks do not increase, indicating the effect is specific to dividends as a commitment device (Brav et al., 2005; Matsumura et al., 2014; Skinner, 2008). Together, these results move beyond average effects and identify the mechanisms and boundary conditions under which disclosure affects payout policy, linking environmental regulation, governance, and financial decisions in a unified framework.

[14] see, for instance, Baboukardos, 2017; Boamah, 2022; Bolton & Kacperczyk, 2021a; Gerged et al., 2021; Jouvenot & Krueger, 2019; Tang & Demeritt, 2018

The rest of this chapter is organised as follows. Section 2 discusses the related literature and sets out the hypotheses. Section 3 describes the data and provides summary statistics. Section 4 explains the research design. Section 5 presents the main results, while Section 6 reports a series of robustness tests. Section 7 offers additional analyses, and Section 8 concludes the chapter.

4.2 Related literature and hypothesis development

The introduction of mandatory carbon disclosure is likely to shape firms' dividend policies, though the direction of the effect is theoretically ambiguous. Dividend choices are informed by competing perspectives: agency costs, information asymmetry, signalling, and precautionary motives, all of which offer different predictions about how disclosure might alter payouts. One strand of reasoning suggests that dividends should decline once disclosure becomes compulsory. Firms required to disclose their greenhouse gas (GHG) emissions face increasing pressure from regulators, investors, and other stakeholders to reduce their carbon footprint and show tangible progress. Prior research shows that sustainability mandates encourage emission reductions, the adoption of abatement technologies, and investment in green innovation (e.g. Aghion et al., 2016; Bratten et al., 2023; Flammer et al., 2021; Jouvenot & Krueger, 2019). These undertakings are both costly and uncertain. From the perspective of the pecking-order theory, managers prefer to finance such activities internally with retained earnings, rather than turning to external capital markets where transaction costs and information frictions are higher (Myers & Majluf, 1984). In addition, theories of precautionary saving emphasise that firms exposed to higher uncertainty tend to conserve liquidity by limiting payouts (Almeida et al., 2004; Bates et al., 2009). Transition risks linked to climate policy, carbon pricing, and the volatility of emerging clean technologies further increase the unpredictability of future cash flows (Bolton & Kacperczyk, 2021a; Ilhan et al., 2021). Under these conditions, cutting dividends allows firms to redirect funds toward environmental projects and build cash buffers.

A related argument views sustainability expenditures as a type of insurance. Investing in responsible environmental practices helps shield firms from reputational damage, litigation, and regulatory sanctions, which in turn supports long-run financial resilience. However, establishing this insurance requires upfront spending, typically financed by holding back cash that might otherwise be distributed. Reducing dividends can thus be understood as part of a broader effort to safeguard against climate-related risks and to satisfy investor expectations for credible sustainability commitments (Chen et al., 2024; Grewal et al., 2019). Given these perspectives, I set out the following hypothesis:

Hypothesis 1a: Dividend payout decreases after mandatory carbon disclosure is introduced.

An alternative perspective predicts the opposite outcome, which is that disclosure requirements lead to higher dividends. Standardised and public information about emissions increases transparency and lowers information asymmetry between insiders and outside investors. Classical research on disclosure demonstrates that transparency mitigates adverse selection and enhances monitoring capacity (Diamond & Verrecchia, 1991; Healy & Palepu, 2001). More recent studies show that sustainability reporting makes firms more comparable and reduces opportunities for misrepresentation (Christensen et al., 2021; Fiechter et al., 2022; Grewal et al., 2019). From the standpoint of agency theory, stronger investor oversight limits managerial discretion to retain cash or engage in projects that do not maximise shareholder wealth (Jensen, 1986; La Porta et al., 2000). In such settings, higher dividend payouts act as a governance tool by committing firms to distribute excess cash.

Signalling theory also supports this channel. Disclosure of carbon emissions may heighten investor concerns that resources will be tied up in environmental projects with uncertain payoffs. Managers can counter these concerns by raising dividends, thereby signalling financial strength and a continued commitment to shareholders (Baker & Wurgler, 2004; Bhattacharyya et al., 2008; Brav et al., 2005; Miller & Rock, 1985). The signalling effect becomes particularly relevant when external scrutiny intensifies. Evidence from China, for instance, indicates that mandatory ESG reporting increased dividend payouts, largely due to stronger shareholder monitoring (Fonseka & Richardson, 2023). Other studies show that disclosure requirements attract institutional investors and enhance firm valuation, both of which can reinforce higher payout policies (Downar et al., 2021; Krueger et al., 2020). In light of the above arguments, I propose the following hypothesis:

Hypothesis 1b: Dividend payout increases after mandatory carbon disclosure is introduced.

Overall, prior work offers competing predictions. On one side, disclosure amplifies investment needs and future cash-flow uncertainty, pushing firms to conserve cash and lower payouts. On the other hand, it improves transparency and strengthens monitoring and signalling mechanisms, which may drive firms to increase dividends. The ultimate effect is therefore an empirical question and is likely to vary across firms depending on characteristics such as ownership structure, investor horizons, and carbon intensity, which I will further analyse in my additional analysis.

4.3 Data and summary statistics

This chapter examines the effect of mandatory carbon disclosure regulation on corporate dividend policy by comparing U.K. firms subject to the regulation with a control sample of European firms. To construct the sample, I collect firm-level financial data for all listed firms on European stock exchanges from S&P Capital IQ over the period 2009–2017. The sample period begins four years prior to the introduction of the U.K. regulation and extends to 2017.

The extended post-regulation window is motivated by prior literature suggesting that firms adjust dividend policies gradually in response to regulatory or governance shocks. Dividend decisions are well known to exhibit smoothing behaviour due to managerial reluctance to reduce payouts once announced and the signalling role of dividends (Brav et al., 2005; Lintner, 1956). As a result, the impact of regulatory changes may take longer to materialise in dividend policy than in other corporate outcomes. Restricting the sample to 2017 also avoids potential distortions arising from the COVID-19 pandemic and related government interventions in dividend payments (Chen et al., 2024).

[Table 4-1 about here]

To identify treated firms, I begin with a comprehensive list of securities traded on the U.K. Main Market of the London Stock Exchange, obtained from the LSE website, and merge this list with the Capital IQ database. Only firms listed on the Main Market are retained, as these firms are directly subject to the mandatory carbon disclosure requirement. U.K. firms not listed on the Main Market are therefore excluded from the treatment group. To ensure comparability across firms, I exclude financial institutions (SIC codes 6000–6999), which operate under distinct regulatory regimes and capital requirements that materially affect their financing and payout decisions (Chang et al., 2024). Firms that never pay dividends during the sample period are further excluded, as dividend payout is not meaningfully defined for these firms. Following John et al. (2011), I also exclude small firms with total assets below USD 100 million, as dividend policy is less stable and less economically meaningful for very small firms.[15] The final sample is an unbalanced panel of 1,838 firms and 16,542 firm-year observations. Industries are classified using SIC codes obtained from Capital IQ and are later used to construct industry fixed effects. All continuous variables are winsorised at the 1st and 99th percentiles to mitigate the influence of extreme observations. Table 4-1 summarises the sample selection procedure and reports the number of firms and firm-year observations retained at each stage of the screening process.

4.3.1 Key independent variables: treatment (U.K.) and control (European) groups

This study uses a DiD framework to evaluate how mandatory carbon disclosure affects dividend policy. The central variable of interest is the interaction between two binary indicators ($Treated_i \times After_t$). The first indicator, $Treated_i$, identifies the treated firms that are listed on the Main Market of the London Stock Exchange and incorporated in the U.K. that became subject to the 2013 Disclosure Act, effective from September 30, 2013. The control group consists of European firms that are not covered by the regulation. The second indicator, $After_t$, equals one for the post-regulation period and zero otherwise.

[15] I exclude small firms with assets below USD 100 million from the analysis because of several reasons. First, small firms often face severe financing constraints and therefore follow very different dividend policies compared to larger, more established firms (Fama & French, 2001). Second, their disclosure incentives and compliance behaviour may be weaker, since smaller firms are less visible to capital markets and often outside the main scope of investor scrutiny (La Porta et al., 2000). Third, small firms are more likely to have volatile earnings and irregular dividend payments, which can distort cross-country comparisons. By restricting the sample to firms above this size threshold, I improve comparability across treatment and control groups and ensure that the results are not driven by outliers or idiosyncratic behaviours of very small firms.

To extend the analysis, I also test whether the impact of mandatory carbon disclosure differs according to firms' emission intensity, institutional ownership, and the level of long-term institutional ownership. This involves estimating a triple-differences (DiDiD) model. Firm-level carbon emissions data, measured in thousand metric tons of carbon dioxide equivalent (thousand MtCO2e), are obtained from Trucost and used to classify firms into high- and low-emission groups. Institutional ownership data are taken from S&P Capital IQ, which provides fiscal year-end holdings for 9,809 distinct investors worldwide with positions in the sample firms. I construct an aggregate measure of institutional ownership at the firm level as follows:

$$IO_{it} = \sum_{j=1}^{n} IO_{\text{jit}} \tag{4-1}$$

where IO_{jit} is the percentage of outstanding shares in firm i held by institutional investor j at the end of year t. The variable IO_{it} represents the total institutional ownership in firm i during year t. This measure is consistent with prior research on institutional ownership and corporate policy (e.g. Dyck et al., 2019; Marshall et al., 2022).

4.3.2 Dependent variable: Dividend payment

The central dependent variable in this study is the dividend payout ratio. This measure is constructed by dividing common dividends declared (in USD millions) by total assets (in USD millions) and then multiplying by 100 to express it as a percentage. This approach allows the dividend policy of firms of different sizes to be compared on a consistent scale. In line with Jouvenot & Krueger (2019), total assets are excluded as a control variable in the regression models because the dependent variable is already normalised by that measure.

To strengthen the validity of the results, I supplement the main specification with several alternative payout policy indicators. First, I consider dividends relative to sales and dividends relative to earnings, which reflect how distributions relate to firms' revenue generation and profitability. Second, I include the natural logarithm of dividend amounts to reduce skewness in the data and to capture proportional changes in payouts. Third, I use the annual growth rate of dividends to account for changes over time rather than absolute levels. Each of these measures provides a different perspective on firms' payout behaviour and helps verify the robustness of the main findings.

Since firms often distribute cash to shareholders not only through dividends but also through share repurchases, I also incorporate repurchase activity into the analysis. Consistent with the dividend variable, the repurchase variable is measured as the total value of repurchases scaled by total assets. This ensures that any observed changes in payout policy are not driven by substitution between dividends and buybacks. Following the approach of Chang et al. (2024), most payout-related variables are multiplied by 100 so that they are expressed in percentage terms, making the interpretation of coefficients more straightforward. Full definitions of the dependent variable and its alternative measures are provided in the appendix.

4.3.3 Control variables

The analysis includes a set of control variables that are commonly identified in the literature as key determinants of dividend policy. To reduce concerns of reverse causality, all firm-level continuous variables are measured with a one-year lag. At the firm level, *retained earnings relative to total assets* are included to capture a company's internal financing capacity. Firms with larger reserves of retained earnings often have greater flexibility to distribute cash to shareholders, while firms with more limited reserves may need to conserve resources for investment and growth (Benlemlih, 2019). *Leverage* is another important determinant, as highly indebted firms typically prioritise debt obligations, leaving less room for dividend payments. In contrast, firms with lower leverage are less constrained in their ability to return cash to investors (Saeed & Zamir, 2021). The *cash ratio* provides a measure of liquidity, reflecting whether firms have sufficient liquid assets to sustain or increase dividend payouts. Firms with stronger liquidity positions are more likely to distribute dividends, whereas less liquid firms may prefer to retain cash (Ellili, 2022).

Sales growth is also controlled for, as rapidly growing firms usually reinvest their earnings to fund expansion rather than distribute them as dividends, while more mature firms with slower growth often return a larger share of earnings to shareholders. Profitability, measured by *return on assets (ROA)*, is expected to influence dividend policy directly; firms with higher profitability generally have both the capacity and the incentive to pay dividends, while less profitable firms may scale back distributions. Finally, a dividend dummy variable (Div dummy) is included to capture firms' historical tendency or commitment to pay dividends. Prior studies show that firms that have paid dividends in the past are more likely to continue doing so, reflecting dividend smoothing and managerial reluctance to cut payouts (Brav et al., 2005; Lintner, 1956). Including this variable helps account for the persistence of dividend behaviour and ensures that the estimated effects are not driven by firms' past payout patterns (Cheung et al., 2018; Michaely & Roberts, 2012a). Detailed definitions and data sources for all variables are provided in Appendix 4-A1.

4.3.4 Summary statistics

Table 4-2 presents the descriptive statistics for the variables employed in this chapter. The main dependent variable, dividend-to-total assets ratio, has a mean value of 1.79% (median 1.12%), suggesting that, on average, all European listed firms on average distribute a modest share of their assets as dividends. The dummy indicator for dividend payment shows that around 68% of firm-year observations report paying dividends, consistent with the idea that dividends remain a widespread but not universal practice among European firms. The dividend-to-earnings and dividend-to-revenue ratios average 14.62% and 2.26%, respectively, while the mean one-year dividend growth rate is 6.59%. These statistics highlight cross-sectional variation in firms' capacity and willingness to distribute cash, reflecting both maturity and financial stability. Such patterns are broadly consistent with evidence from the European and U.S. markets, where dividends remain the dominant payout channel despite the increasing use of share repurchases (Denis & Osobov, 2008; Farre-Mensa et al., 2014; Michaely & Roberts, 2012b). The means and standard deviations of the main variables appear reasonable and are largely consistent with prior studies (e.g Chang et al., 2024; Fonseka & Richardson, 2023).

[Table 4-2 about here]

The environmental variables highlight considerable variation across firms. Total carbon intensity averages 0.40 thousand tons of CO_2 equivalent per USD million of revenues (median 0.23), indicating that for every USD 1 million in sales, firms emit approximately 400 tons of CO_2e on average. Scope 1 intensity and emissions display similar variation, reflecting differences in direct operational emissions across industries. This dispersion is in line with prior studies documenting significant cross-industry variation in environmental performance and disclosure (Bolton & Kacperczyk, 2021a; Krueger, 2015).

The firm-level control variables indicate that the sample consists primarily of large, mature companies with moderate leverage and profitability. The average leverage ratio is 0.57, the cash ratio is 0.11 and return on assets averages 3.83%. Firms report average sales growth of 4.95%, though with substantial dispersion, and retained earnings account for roughly 39% of total assets. R&D expenditures are low (1.4% of assets), in line with a sample dominated by mature industries. The average firm age is 73 years, further confirming the maturity of the sample firms.

For the additional controls, I also add the country-level variables, the average log GDP is 10.54, GDP growth is modest at 1.32%, and inflation is relatively low (1.70%), capturing the macroeconomic environment of developed European economies. The mean investor protection index of 6.85 highlights cross-country institutional variation, which may shape the governance role of dividends. In settings with stronger investor protection, dividends may serve less as a substitute governance mechanism, whereas in weaker protection environments, higher payouts can be used to mitigate agency conflicts.

Panel B reports the matrix of correlations. Overall, correlations among the independent variables are moderate, with the highest coefficient between GDP and inflation ($r = 0.48$), which does not raise concerns of multicollinearity. I also conduct variance inflation factor (VIF) tests, which are not shown in the tables, and the results indicate that multicollinearity is not a concern. All VIF values are comfortably below the commonly accepted cutoff of 5. The correlation patterns are consistent with prior literature in which dividend payout is positively associated with profitability and firm age, while showing a negative relationship with leverage and volatility (e.g. Fama & French, 2001; Michaely & Roberts, 2012). Most control variables display statistically significant relationships with the dependent variable that are in line with expectations.

Figure 4-1 plots the annual mean (Panel A) and median (Panel B) dividend payout ratios for U.K. and EU firms over the period 2009–2017. The dividend payout ratio is measured as dividends scaled by total assets. The vertical line marks the introduction of mandatory carbon disclosure in the U.K. in 2013.

[Figure 4-1 about here]

Prior to 2013, I observe broadly similar trends in dividend payout ratios between U.K. and EU firms. Both the mean and median values evolve in parallel, suggesting comparable pre-regulation payout behaviour across the two groups. This visual evidence supports the identification strategy by indicating the absence of systematic divergence before the policy change.

Following the introduction of mandatory carbon disclosure, a divergence gradually emerges. In particular, the mean dividend payout of U.K. firms begins to increase relative to EU firms, with the difference becoming more pronounced after 2016. The upward movement in the mean suggests that, on average, treated firms distribute a higher proportion of assets as dividends in the post-regulation period compared to the control group. The adjustment does not appear to be immediate in 2013; instead, dividend payouts rise progressively over time.

The median dividend payout exhibits a similar but smoother pattern, indicating that the observed increase is not driven solely by a small number of large dividend-paying firms. Rather, it reflects a broader shift in payout behaviour among treated firms. This gradual response is consistent with dividend smoothing theory, which suggests that firms adjust payout policies cautiously and incrementally rather than implementing abrupt changes. Overall, the graphical evidence suggests that mandatory carbon disclosure is associated with a gradual increase in dividend payouts among U.K. firms relative to EU firms, particularly in the later post-regulation years. These descriptive patterns complement the regression results by illustrating both the timing and persistence of dividend adjustments following enhanced disclosure requirements.

4.4 Research design

Consistent with previous research, I choose to standardise cash dividends using total assets instead of earnings or market value for several reasons. Firstly, earnings are susceptible to manipulation through accounting practices to achieve certain goals. Secondly, as La Porta et al. (2000) point out, resource misappropriation may happen before earnings are reported, causing the dividend-to-earnings ratio to exaggerate the actual proportion of earnings paid as dividends. Thirdly, the payout ratio can become unstable due to low earnings, potentially distorting results. Finally, utilising the cash dividend to market capitalisation ratio could introduce valuation issues from low stock prices. To mitigate these issues associated with earnings and market capitalisation, this study employs cash dividends in relation to total assets, as total assets exhibit greater resistance to manipulation and misappropriation.

To examine how the regulation influenced dividend policy, I employ a difference-in-differences (DID) research design. This method evaluates whether the change in outcomes for firms subject to the mandate differs from the change observed in a comparable set of firms that were not affected. In this context, the "treatment group" consists of U.K. companies listed on the main market, which were required to disclose their greenhouse gas emissions following the introduction of the law. The "control group" is made up of listed firms in other European countries that were not covered by the mandate during the same period. By comparing changes in dividends before and after the introduction of the law across these two groups, the DID approach mimics an experimental setting. The key idea is that any common time trends in dividend policies among European firms are differenced out, isolating the relative change observed in U.K. firms as the estimated effect of mandatory carbon disclosure. Hence, the quasi-natural experiment allows us to estimate the incremental effect of the mandatory disclosure requirement. The regulation came into effect in September 2013; however, the exact year in which each firm became subject to it depends on the firm's fiscal year-end date. This created a staggered implementation process: firms with fiscal years ending on or after September 30 were required to comply in 2013, while those with fiscal years ending before September 30 became compliant in 2014. Accordingly, this study identifies each firm's specific compliance year based on this timing structure.

Assuming the null hypothesis holds, if the mandatory disclosure rule has no effect on dividend policy, the change in cash dividend payments should be similar for U.K. firms and their European counterparts. To test this, I estimate a difference-in-differences (DID) regression model:

$$Y_{it} = \alpha + \beta_1(\text{Treated}_i \times \text{After}_t) + \beta_2\text{Treated}_i + \beta_3\text{After}_t + \beta_4X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it} \tag{4-2}$$

In this equation, t indexes event years, and the dependent variable is the dividend payout ratio, which I measure as the common dividend declared divided by total assets. *Treated*, indicating if the firm is a U.K. company listed on the Main Market of the LSE. $After_t$ is a dummy variable that equals one in event years in which U.K. firms must comply with the disclosure law, and zero otherwise. As explained above, the timing of the regulation is tied to each firm's fiscal year-end. Accordingly, the *After* indicator captures the staggered rule implementation across firms. X_{it-1} is a one-year lag vector of firm-level controls, and the details of control variables are shown in section 4.3.3. I also control for event year (γ_t), industry (τ_j), and stock exchange fixed effects (λ_s), respectively. Each firm's industry is identified using the SIC classification system.

The key variable of interest is therefore the interaction term between *Treated* and *After*. Its coefficient, β_1, captures the difference in dividend payments between U.K. firms subject to the rule and comparable European firms once the regulation takes effect. If the regulation has no influence on dividend policy, β_1 won't be statistically significant. Conversely, a statistically significant estimate of β_1 would suggest that the regulation influenced firms' dividend behaviour.

In the multivariate analysis, I account for characteristics that may be jointly related to both mandatory carbon disclosure and dividend policy. *Industry* fixed effects reduce the risk that systematic differences in dividend policy across sectors, or the concentration of certain firms in specific industries, are driving the results. Consistent with earlier studies (Bilyay-Erdogan et al., 2023; Jouvenot & Krueger, 2019), the regressions in this empirical chapter therefore include industry fixed effects at the four-digit SIC level, together with year and stock exchange fixed effects. *Year* dummies help capture common time patterns, such as the overall decline in the share of firms paying dividends. *The stock exchange fixed effects* are included to account for time-invariant cross-country differences, such as variations in economic development, institutional structures, cultural norms, and regulatory frameworks. This approach ensures that the analysis isolates the effect of the disclosure regulation from persistent country-specific characteristics. To obtain reliable inference, in the main analysis, I employ robust standard errors, clustered at the stock exchange level, following the methodological framework of Jouvenot and Krueger (2019).

It is important to interpret the findings of this chapter within the broader regulatory environment in which the disclosure reform occurred. As discussed in Section 2.6, the introduction of mandatory carbon disclosure in 2013 coincided with the implementation of the U.K. Carbon Price Floor, which increased the effective carbon price faced by U.K. firms relative to many European counterparts. While carbon pricing primarily affects firms through cost and operational channels, the focus of this chapter is on financial policy responses, specifically dividend payout behaviour, associated with enhanced transparency and investor monitoring. The empirical design therefore isolates the differential impact related to mandatory disclosure, rather than the direct cost effects of carbon pricing, although both reforms form part of the wider climate policy context.

4.4.1 Parallel trend assumption

An important issue to consider is whether the results are influenced by pre-existing differences between U.K. firms and their European counterparts rather than by the disclosure regulation itself. If firms that typically pay higher dividends already differ systematically from those with lower payouts, the findings could simply reflect these characteristics. For instance, larger firms are often regarded as having more stable earnings and growth prospects, which makes them more inclined to distribute higher dividends compared to smaller firms. To address this concern, I examine Figure 4-2, which compares firm-level dividend payouts measured as common dividends declared relative to total assets for U.K. firms (treatment group) and European firms (control group) around the time the regulation was introduced. This analysis is carried out within the DID framework, incorporating both control variables and fixed effects.

As mentioned earlier, the timing of a firm's compliance with the regulation is determined by its fiscal year-end, following the spirit of Jouvenot and Krueger (2019). To do so, I rely on specification (4-2), where the *After* dummy is replaced with a set of year-specific dummies covering the period from 2009 to 2017. This specification is employed to estimate the changes in dividend payout before and after the regulation. The depicted point estimates represent the mean difference in dividend payment between the U.K. firms and those in Europe in a given year relative to the year 2012 (base year). This is why the year 2012 does not appear in the figure. My specification on my main hypothesis would be invalid if the average differences in dividend payout between European and U.K. firms were to diverge prior to the implementation of the regulation.

[Figure 4-2 about here]

Figure 4-2 presents the yearly average difference in dividend payouts between firms. The dependent variable is measured as common dividends declared, scaled by total assets. The figure plots the coefficients from regressions that interact the *Treated* dummy with year-specific event-time indicators around the introduction of the regulation, with 95 per cent confidence intervals shown as shaded regions, and the estimates are expressed relative to the baseline year 2012. The detailed regression estimates that generate Figure 4-2 are provided in Appendix Table 4-A2.

The results show that, the pre-treatment coefficients (2009–2011) are generally small in magnitude and statistically indistinguishable from zero. I do not observe a systematic upward or downward pattern prior to the introduction of the regulation. This absence of consistent pre-treatment divergence indicates that treated and control firms followed similar dividend payout trajectories before 2013. If one pre-treatment coefficient appears statistically significant, I interpret this isolated significance cautiously. A single significant estimate, particularly when economically small and not part of a consistent pattern, may arise due to sampling variation rather than a genuine violation of the parallel trend assumption. As emphasized by Angrist and Pischke (2009), isolated pre-period significance does not invalidate a DiD design when it is not accompanied by systematic divergence. Bertrand et al. (2004) similarly demonstrate that sampling variation and serial correlation can generate occasional significant estimates even when the identifying assumption holds. Therefore, I focus on the overall pattern of pre-treatment coefficients rather than on individual significant estimates. Because I do not observe consistent divergence before the regulation and because differences emerge only after 2013, I conclude that the parallel trends assumption is satisfied. Accordingly, the DiD estimates can be interpreted as capturing the causal impact of mandatory carbon disclosure on firms' dividend payout policies.

In this study, I do not apply propensity score matching (PSM) before implementing the Difference-in-Differences (DiD) framework. The validity of the DiD approach primarily depends on the parallel trends assumption, which I explicitly examine and confirm using the event-study specification (Angrist & Pischke, 2009). In addition, the number of firm-level carbon emissions observations in my dataset is relatively limited, and applying PSM would further reduce the sample size, thereby weakening statistical power and increasing estimation inefficiency (Heckman et al., 1997). Moreover, recent methodological research suggests that PSM can increase imbalance and bias when applied inappropriately, a concern often referred to as the "PSM paradox" (King & Nielsen, 2019). For these reasons, I focus on testing and validating pre-treatment parallel trends rather than matching firms prior to estimation.

4.5 Baseline results: Does mandatory carbon disclosure affect dividend payment decision?

Table 4-3 reports the baseline regression estimates of how the U.K. mandatory carbon disclosure regulation influenced firms' dividend payouts using the specification (4-2). Across all three model specifications, the coefficient on the *Treated* × *After* interaction is positive and statistically significant at the 1% level. This result shows that U.K. firms subject to the disclosure rule raised their dividend payments compared with similar European firms that were not affected. The evidence suggests that the regulation had a clear impact on payout behaviour, supporting the idea that increased transparency reduces information asymmetry and constrains managerial discretion (Hail et al., 2014; La Porta et al., 2000). These findings are consistent with Hypothesis 1b, which predicts that dividend payouts rise following mandatory disclosure, and they provide no support for Hypothesis 1a, which anticipated a decline.

[Table 4-3 about here]

Specifically, in the simplest specification (Model 1), the estimated coefficient on *Treated* × *After* is 0.2863. This implies that following the disclosure mandate, U.K. firms increased their dividend-to-assets ratio by approximately 0.29 percentage points compared to European firms. Relative to the sample mean dividend ratio of U.K. firms, 2.72%, this represents an economically large increase of 10.53% (0.2863/2.72 = 10.53%). In monetary terms, given that the average total assets of treated firms are approximately 9,511 million USD, this corresponds to an average increase of about USD 27.23 (0.2863%*9511=27.23) million in dividend payments**.** This effect suggests that mandatory carbon disclosure enhances investor monitoring and induces firms to commit to higher payouts to mitigate reputational risks and signal financial stability, consistent with Baker and Wurgler (2004) and Brav et al. (2005).

Model (2) adds firm-level control variables, including retained earnings, leverage, cash ratio, sales growth, and return on assets (ROA). The coefficient on *Treated* × *After* declines slightly to 0.2292 but remains highly significant. This suggests that while firm characteristics explain part of the variation in dividend policy, the positive impact of the regulation persists after accounting for these factors. This aligns with recent evidence from Fonseka & Richardson (2023), who report that mandatory ESG disclosure in China is associated with higher dividends due to improved shareholder monitoring.

Finally, Model (3) extends the specification to include a lagged dividend dummy to capture dividend persistence. Even with this additional control, the coefficient on *Treated* × *After* remains positive (0.2364); specifically, treated firms increase their dividend payment by approximately 8.69% (0.2364/2.72 = 8.69%) after the regulation compared to control firms, highlighting that the observed effect is not simply a reflection of dividend stickiness. Expressed in monetary terms, given that the average total assets of treated firms are approximately 9,511 USD million, this effect corresponds to an average increase of about 22.48 USD million (0.2364% × 9,511 = 22.48) in dividend payments. This finding reinforces earlier insights by

Balachandran & Nguyen (2018), who emphasise the importance of controlling for payout history when studying dividend determinants. In Model (3), I include a lagged dividend dummy variable to account for the well-documented persistence of dividend payments. Firms that have paid dividends in the past are considerably more likely to continue doing so, reflecting managers' reluctance to cut payouts once initiated, given the negative market signals associated with dividend reductions (Brav et al., 2005; Lintner, 1956). The inclusion of this control is also consistent with signalling theory (Miller & Rock, 1985), which suggests that firms use stable or increasing dividends to convey financial strength, and with the life-cycle theory (DeAngelo et al., 2006), which predicts that mature firms with established payout histories rarely change their dividend status abruptly. Following Balachandran & Nguyen (2018), the use of the dividend dummy thus allows the model to more precisely isolate the incremental impact of mandatory carbon disclosure on dividend policy.

Overall, the baseline results support the hypothesis that mandatory carbon disclosure leads to higher dividend payments. This outcome aligns with the predictions of agency theory (Jensen, 1986), which argues that closer monitoring limits managers' ability to retain excess cash and encourages them to distribute more to shareholders. It also fits with signalling theory, which holds that firms may raise dividends to demonstrate financial stability and reinforce their commitment to shareholder value when external scrutiny increases (Bhattacharyya et al., 2008; Miller & Rock, 1985). Importantly, the findings extend the literature by demonstrating that non-financial disclosure regulations can shape core financial policies, echoing earlier evidence that ESG disclosure influences financing and investment decisions (Grewal et al., 2019; Ioannou & Serafeim, 2017). The economic significance of the effect is notable. Based on Model (3), the estimated coefficient of 0.2364 translates into an 8.69% increase in dividend payouts relative to the sample mean. This magnitude suggests that the regulation did not merely shift disclosure practices but also altered firms' financial decision-making in a meaningful way.

Similar magnitudes are reported in related studies of mandatory non-financial disclosure, where increased transparency leads to changes in payout policies (e.g. Chang et al., 2024; Fonseka & Richardson, 2023).

The coefficients of the control variables largely conform to theoretical expectations and prior empirical evidence, providing further credibility to the results. The results show a positive and significant association between retained earnings and dividend payouts, which is consistent with the life-cycle view of dividends (DeAngelo et al., 2006). Firms that are more mature and have built up larger profit reserves are better positioned to distribute cash to shareholders. This finding is in line with earlier evidence reported by Benlemlih (2019) and Chen et al. (2024) that retained earnings are a strong predictor of payout levels. Leverage shows a negative association with dividends. This result supports Jensen’s free cash flow theory, which argues that debt acts as a substitute governance mechanism by reducing managers’ ability to overinvest. Firms with higher debt obligations retain more cash for interest and principal payments, thereby lowering dividends. This negative relation has also been documented in earlier studies, such as Agrawal & Jayaraman (1994) and Chang et al. (2024). The cash ratio is strongly positive and highly significant, indicating that firms with greater liquidity distribute more dividends. This result is in line with the precautionary view of cash holdings, which suggests that firms retain cash as a safeguard against future uncertainty (Opler et al., 1999), which suggests that once firms have sufficient liquidity buffers, excess cash is more likely to be returned to shareholders. The magnitude of the coefficient highlights the importance of liquidity in shaping payout policies, particularly under the heightened monitoring environment created by carbon disclosure mandates.

Sales growth is negatively associated with dividends, which is consistent with life-cycle theory. Firms experiencing rapid growth are more likely to retain earnings in order to fund new investment opportunities rather than distribute them as dividends (DeAngelo et al., 2006). This pattern aligns with prior evidence showing that firms with strong growth prospects typically pay lower dividends (Dixit et al., 2020). This result is also consistent with the predictions of agency theory, as managers in growth firms face fewer pressures to distribute cash given the availability of investment projects. ROA exhibits a large, positive, and highly significant effect, confirming that profitability is a key driver of dividend policy. More profitable firms are better positioned to reward shareholders, a result consistent with classic findings by Fama & French (2001) and more recent evidence from Michaely & Roberts (2012). The magnitude of the ROA coefficient underlines the importance of current earnings in dividend decisions, even when controlling for retained earnings and other firm characteristics. The lagged dividend dummy in Model (3) is also positive and highly significant, capturing the well-documented persistence of dividend payments (Brav et al., 2005; Lintner, 1956). This result indicates that firms which paid dividends in the previous year are substantially more likely to continue doing so, highlighting the stickiness of payout policies. Importantly, the significance of the *Treated* × *After* coefficient even after including this control confirms that the regulation had an independent effect beyond natural dividend persistence.

In summary, the baseline results provide strong and consistent evidence that mandatory carbon disclosure leads to higher dividend payouts among U.K. firms relative to European firms. The findings are in line with agency theory and signalling theory, and they are broadly consistent with prior empirical studies on the effects of ESG and CSR disclosure on payout policy (Benlemlih, 2019; Chang et al., 2024; Fonseka & Richardson, 2023). By linking mandatory carbon disclosure to dividend outcomes, this study adds new evidence that non-financial reporting mandates can influence core aspects of corporate financial policy, thereby extending our understanding of the intersection between sustainability regulation and shareholder value. The following section presents a set of robustness tests designed to ensure that the results are not explained by alternative factors, such as random treatment effects, omitted variable bias, and the alternative of the dependent variable. These additional tests help ensure that the positive relationship identified between disclosure and dividend payouts reflects a genuine causal effect of the regulation.

4.6 Robustness checks

This section presents a range of robustness tests aimed at verifying the reliability of the baseline results. The main analysis shows a statistically significant and positive association between firms' dividend payout ratios and mandatory carbon disclosure in the post-regulation period. To ensure that this result is not driven by other factors, I test them further. In particular, I conduct placebo tests, use alternative measures of dividend payouts to address potential confounding factors, and apply robustness checks to mitigate concerns about omitted variable bias.

4.6.1 Additional Control Variables

To address potential concerns of omitted variable bias, the main difference-in-differences (DiD) specification is re-estimated by including additional firm- and country-level control variables that have been previously used in the corporate finance and dividend literature. Specifically, the extended model adds research and development expenditures (R&D), firm age, and four macroeconomic indicators: GDP per capita, GDP growth, inflation, and the investor protection index (IPD), as defined in Appendix 4-A1. The results are presented in Table 4-4.

[Table 4-4 about here]

The findings show that the coefficient on the interaction term (*Treated* × *After*) remains positive and statistically significant at the 1% level ($\beta_1 = 0.2378$), consistent with the baseline results. This indicates that the positive effect of mandatory carbon disclosure on firms' dividend payouts is robust to the inclusion of these additional controls. In particular, the results suggest that the regulation continues to exert a significant influence on dividend behaviour even after accounting for firm-specific and macroeconomic differences across countries.

Among the additional variables, *R&D expenditure* is positive and statistically significant, suggesting that firms engaging more in innovation tend to distribute higher dividends, possibly reflecting stronger financial performance and investor confidence. *Firm ag***e** shows a small and statistically insignificant coefficient, implying that maturity effects are already captured by other firm-level controls such as retained earnings and profitability. Likewise, the country-level variables (GDP per capita**,** GDP growth**,** inflation, and IPD) are statistically insignificant, indicating that macroeconomic conditions and institutional factors do not materially explain the observed variation in dividend payouts.

Overall, the robustness analysis confirms that the main findings are not driven by omitted variable bias. The estimated treatment effect remains stable in both magnitude and significance after controlling for additional firm characteristics and macroeconomic conditions, reinforcing the credibility of the causal interpretation that the mandatory carbon disclosure regulation increased dividend payouts among U.K. firms relative to their European counterparts.

4.6.2 Pseudo treatment

As a further robustness check, I conduct a placebo analysis by creating a pseudo-treatment group. In Table 4-5, firms are randomly divided into treatment and control groups, with the number of firms in the pseudo-treatment group matching the actual number of U.K. firms subject to the disclosure regulation. A dummy variable is then assigned, taking the value of one for randomly selected treatment firms and zero otherwise. I re-estimate the difference-in-differences regressions over the 2009–2017 period using this random assignment. To ensure robustness and eliminate the influence of random chance, the random assignment is repeated five times, with each iteration reported in Models (1) to (5) of the table. The results, reported in Table 4-5, show that the interaction term (*Treated* × *After*) is statistically insignificant across all five model specifications. This indicates that no systematic effect is observed when the treatment status is assigned randomly. These findings strengthen the validity of the baseline results by confirming that the positive and significant effect documented earlier is not a product of random chance but instead reflects the genuine impact of the U.K. carbon disclosure regulation on dividend policy.

[Table 4-5 about here]

4.6.3 Alternative measures of a firm's dividend payout ratio

My main results are based on the dividend-to-assets ratio, which measures common dividends declared scaled by total assets. To ensure that the findings are not dependent on this particular construction of the dependent variable, I re-estimate the models using four alternative payout measures commonly used in the literature (e.g. Bae et al., 2012; Chen et al., 2024; Sharma, 2011). These alternatives are (1) dividends divided by total sales, (2) dividends divided by earnings, (3) the natural logarithm of dividends, and (4) one-year growth in dividends per share.

[Table 4-6 about here]

The results, reported in Table 4-6, show that the coefficient on the *Treated* × *After* interaction remains positive and statistically significant across all four measures. For instance, the effect is 0.4078 when dividends are scaled by sales, and 1.2331 when scaled by earnings, both statistically significant at 1% level, respectively. Using the log of dividends as the dependent variable also shows a positive coefficient (0.1497), while the specification based on one-year dividend growth yields an estimate of 1.9413, which is significant at the 1% and 10%

levels, respectively. The economic magnitudes are also meaningful. The coefficient of 1.2331 in the dividend-to-earnings specification implies that U.K. firms increased their dividend payouts by 1.2 percentage points of earnings relative to European firms after the regulation. Similarly, the coefficient of 1.94 on dividend growth indicates that, on average, treated firms raised their annual dividend growth rate by nearly two percentage points compared to the control group. These estimates confirm that the effect of mandatory carbon disclosure on dividend policy is not only statistically significant but also economically substantial. Overall, the consistency of the results across all four alternative measures reinforces the conclusion that the positive impact of the U.K. disclosure mandate on dividend payouts is robust. It rules out the possibility that the baseline findings are an artefact of the specific way dividends are scaled, strengthening confidence in the validity of the main results.

4.7 Additional analyses

4.7.1 Does treatment effect depend on institutional ownership?

The U.K. mandatory carbon disclosure regulation requires firms to report their greenhouse gas emissions in a standardised way (Jouvenot & Krueger, 2019). The baseline analysis shows that this regulation lead U.K. firms to increase dividend payouts compared with European peers. A key channel through which this effect may operate is institutional ownership. Prior research suggests that institutional investors are effective monitors who can reduce information asymmetry, curb managerial discretion, and influence payout decisions (Shleifer & Vishny, 1986; Short et al., 2002). When disclosure requirements increase transparency, institutional investors gain better tools to evaluate firm behaviour and may pressure firms to distribute higher dividends to mitigate agency problems.

Furthermore, my previous empirical research on the effects of carbon emissions on institutional ownership (Chapter 3) indicates that firms complying with carbon disclosure regulations tend to attract greater investment from institutional investors, consistent with the findings of Marshall et al. (2022). Literature also suggests that institutional investors can alleviate financial constraints by enhancing corporate governance, reducing information asymmetry, and shaping capital structure decisions (e.g. Chung et al., 2010; Schain & Stiebale, 2021). Their presence can reduce the need for firms to hold large precautionary cash reserves, as access to external financing becomes less constrained. Moreover, mandatory carbon disclosure exposes firms to greater stakeholder scrutiny, which can motivate insiders to adopt practices that enhance reputation and strengthen investor trust (Cheung et al., 2018). Institutional investors, who often have longer horizons and stronger governance preferences, are especially influential in this setting. Their presence can amplify the effect of disclosure on payout policy by demanding more disciplined cash distribution and limiting the scope for managers to retain earnings for private benefits. From the perspective of signalling theory (Miller & Rock, 1985), firms facing higher institutional oversight may also use dividend increases as a credible signal of financial strength and commitment to shareholder value.

[Table 4-7 about here]

To examine whether institutional ownership moderates the effect of mandatory carbon disclosure on dividend policy, I extend the baseline difference-in-differences framework into a difference-in-difference-in-differences (DiDiD) design. This approach allows me to examine how variation in the actual proportion of shares held by institutional investors influences the regulation's impact on payouts. Specification (4-3) incorporates this interaction term DiDiD (*Treated* × *After* × *IO*), alongside industry, year and stock exchange-level fixed effects, to examine whether the impact of disclosure on dividends varies with institutional ownership.

This approach follows recent studies emphasising the role of ownership structure in moderating regulatory effects (Chung et al., 2010; Marshall et al., 2022).

$$Y_{it} = \alpha + \beta_1 . (Treated_i \times After_t \times IO_{it}) + \beta_2 . (Treated_i \times After_t) + \beta_3 . Treated_i + \beta_4 . After_t + \beta_5 . \boldsymbol{X}_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it} \quad (4\text{-}3)$$

In the model, Y_{it} denotes the dividend payout ratio for firm i in year t, calculated as common dividends declared divided by total assets. The main explanatory variable is the triple interaction term (*Treated* × *After* × *IO*), which is designed to test whether the effect of mandatory carbon disclosure depends on the level of institutional ownership. Specifically, this interaction captures whether firms with higher institutional investor presence are more responsive to the regulation in terms of their dividend policy. Institutional ownership at the firm level, IO_{it}, is measured as the percentage of outstanding shares held by institutional investors. The treatment indicator, $Treated_i$, takes the value of one for U.K. firms subject to the regulation, while $After_t$ equals one for the post-regulation period, defined as 2013 for firms with fiscal years ending on or after September 30, and 2014 for those with earlier fiscal year ends, consistent with Jouvenot and Krueger (2019). The vector of lagged firm-level controls, X_{it-1}, accounts for financial characteristics that may also influence payout decisions, while fixed effects for industry, year, and stock exchange are included to capture unobserved heterogeneity. The triple interaction is of particular interest because prior research highlights the monitoring role of institutional investors, who can constrain managerial discretion and influence corporate financial policies (Dyck et al., 2019; Marshall et al., 2022). By including this interaction, the model goes beyond estimating the average effect of mandatory disclosure and sheds light on how institutional ownership strengthens or weakens the link between regulation and dividend payouts.

The results, reported in Table 4-7, show that the coefficient on the triple interaction term is positive and highly significant across all specifications. In column (1), the coefficient is 0.0244, rising to 0.0317 in column (2), and remaining significant in column (3) (coefficient 0.0241). These findings indicate that the positive effect of mandatory disclosure on dividend payouts is stronger in firms with higher institutional ownership. Put differently, the dividend response to disclosure is magnified when institutional investors hold a larger stake in the firm. The economic significance is also notable. I estimate three different specifications to examine how institutional ownership moderates the effect. In Model (1), I include year, stock exchange, and industry fixed effects, which jointly control for time shocks, cross-country institutional differences, and systematic industry-level variation. Models (2) and (3) reduce the number of fixed effects to two in order to check whether the results are sensitive to alternative specifications. Specifically, Model (2) drops industry fixed effects, while Model (3) excludes stock exchange fixed effects. Comparing across these models shows that the coefficient on the triple interaction term (*Treated* × *After* × *IO*) remains positive and statistically significant in all cases, though the magnitude is slightly higher in Model (2). This robustness check is important because including multiple layers of fixed effects, while controlling for unobserved heterogeneity, may also absorb too much variation and potentially bias estimates if over-specified (Cameron et al., 2010; Wooldridge, 2002). By presenting Models (2) and (3), I demonstrate that the findings are not driven by a specific set of fixed effects but hold consistently across alternative designs. This approach follows best practice in empirical corporate finance, where multiple model specifications are used to confirm that key results are not artefacts of modelling choices (Bertrand et al., 2004; Petersen, 2008).

These results are consistent with agency theory (Jensen, 1986), which posits that dividends serve as a governance mechanism to reduce free cash flow problems. Institutional investors strengthen this mechanism by demanding higher payouts when disclosure makes managerial actions more visible. They also align with monitoring-based perspectives that highlight the disciplining effect of concentrated institutional ownership (Chung et al., 2010; Shleifer & Vishny, 1986). These results are also in line with Benlemlih (2019) and Fonseka & Richardson (2023), who find that firms with better governance and clearer ESG reporting tend to pay higher dividends.

Overall, this analysis suggests that institutional ownership plays an important moderating role in shaping how firms respond to mandatory carbon disclosure. By enhancing monitoring and reinforcing investor pressure, higher institutional ownership amplifies the positive effect of disclosure on dividend payouts. This finding adds nuance to the baseline results by showing that the impact of disclosure regulation is conditional on the firm's ownership structure, thereby connecting environmental regulation, governance, and payout policy into a unified framework.

4.7.2 Does the treatment effect depend on the investment horizon?

My earlier analysis provides evidence that mandatory carbon disclosure increases dividend payouts and that institutional ownership strengthens this effect. However, institutional investors differ significantly in their investment horizons, which can alter how disclosure affects financial policy. Long-term investors, such as pension funds and sovereign wealth funds, tend to be more patient, stability-oriented, and committed to monitoring managers, aligning corporate behaviour with sustainable value creation (Aghion et al., 2013; Dyck et al., 2019). By contrast, short-term or transient investors prioritise immediate portfolio returns and exhibit high turnover, which can limit their monitoring capacity and encourage managerial myopia (Bushee, 1998; Stein, 1989). It is therefore essential to consider the moderating role of investment horizons in shaping dividend responses to disclosure regulation.

To address this question, I estimate a triple-differences (DiDiD) specification that interacts the treatment effect of the U.K. mandate with the proportion of firm-level ownership by long-term and short-term investors using specification (4-4).

$$Y_{it} = \alpha + \beta_1.\ (Treated_i \times After_t \times Type_{it}) + \beta_2.\ (Treated_i \times After_t) + \beta_3.\ Treated_i + \beta_4.\ After_t + \beta_5\ .\ \boldsymbol{X}_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it} \quad (4\text{-}4)$$

where the variable *Type* serves as a proxy, representing the actual percentage of firm-level ownership held by either long-term or short-term institutional investors. The results of specification (4-4) are presented in Table 4-8. The Y_{it} is the main dependent variable, which is the dividend payment for firm i in year t. The remaining variables are defined as outlined in Model (4-2).

[Table 4-8 about here]

Table 4-8 reports the findings. The coefficient of model (1) on the triple interaction term *Treated* × *After* × *Type* is positive and highly significant; the coefficient is 0.0262. This indicates that firms with greater long-term institutional ownership increased their dividend payouts noticeably after the introduction of mandatory carbon disclosure. The result highlights the monitoring role of long-horizon investors, who are more likely to value sustainable practices and encourage firms to commit to regular cash distributions as a signal of financial strength and accountability. In contrast, the coefficient for short-term institutional investors is negative and statistically insignificant, the coefficient is -0.0279. This suggests that the presence of short-horizon investors has no measurable effect on dividend policies in the post-regulation period. Unlike long-term investors, short-term shareholders may be less focused on sustainability disclosures and less inclined to pressure firms toward consistent payout adjustments. Overall, the results provide strong evidence that differences in investment horizon are a key factor behind the heterogeneity in firms' dividend responses to mandatory carbon disclosure.

The mechanisms underpinning these findings can be explained by agency and signalling theories. Agency theory suggests that dividends serve as a governance tool to reduce managerial discretion over free cash flows (Jensen, 1986). Mandatory disclosure already reduces information asymmetry, but long-term institutional investors amplify this effect by pressuring managers to commit cash to shareholders rather than retain it for discretionary use (Benlemlih, 2019; La Porta et al., 2000). From a signalling perspective, dividend increases serve as a credible signal of financial stability under heightened scrutiny (Baker & Wurgler, 2004; Hail et al., 2014). Long-term investors, who are especially sensitive to reputation and sustainable performance, are more likely to demand such signals, thereby reinforcing the link between disclosure and dividend policy (Cohen et al., 2023; Starks et al., 2017).

By contrast, firms with a high proportion of short-term investors do not show similar dividend adjustments. This aligns with prior evidence that short-term investors emphasise flexibility, portfolio liquidity, and immediate returns rather than sustained payouts (Bolton et al., 2006; Cremers et al., 2020). Their limited monitoring capacity may weaken the disciplining force of disclosure, allowing managers to maintain discretionary cash reserves or pursue opportunistic investments (Ward et al., 2018). Moreover, transient investors may prefer alternative payout channels, such as opportunistic buybacks, which provide greater short-term flexibility (Bonaimé, 2015). The insignificant effect observed for short-term investors is consistent with this logic, highlighting that these investors neither reinforce nor significantly constrain the dividend response to disclosure.

Overall, the results underscore that the effectiveness of disclosure regulation is contingent on the horizon of institutional investors. Firms with greater long-term ownership respond to disclosure by raising dividends, reflecting stronger oversight and alignment with long-term value creation. In contrast, firms dominated by short-term investors display no systematic dividend changes, consistent with weaker monitoring incentives and short-term preferences. These findings extend the literature on mandatory disclosure (Downar et al., 2021; Jouvenot & Krueger, 2019) by demonstrating that investor horizons critically condition how non-financial reporting affects corporate payout strategies. For policymakers, this suggests that disclosure mandates are most effective in fostering shareholder-friendly financial discipline when complemented by an investor base oriented toward long-term governance.

4.7.3 Does the treatment effect depend on the carbon emissions level?

My baseline results of this chapter suggest that mandatory carbon disclosure increases dividend payouts on average. However, this effect may differ depending on the firms' carbon emissions levels. Prior research shows that high-emission firms are subject to greater regulatory scrutiny, reputational risks, and investor monitoring compared with low-emission firms (Bolton & Kacperczyk, 2021a; Ilhan et al., 2021). These pressures can influence financial policies, including dividends, in ways that differ across firms. It is therefore important to test whether the dividend response to disclosure depends on firms' carbon intensity.

From a theoretical perspective, emissions levels may act as a conditioning mechanism that interacts with agency theory and stakeholder theory. High-emission firms often have higher information asymmetry and weaker governance, which heightens agency problems (Amin et al., 2024). Mandatory disclosure enhances transparency and provides institutional investors and stakeholders with better tools to monitor these firms, reducing managers' discretion over free cash flows (Dyck et al., 2019). At the same time, high-emission firms may face significant compliance costs and litigation risks, which limit their ability to increase payouts. In line with signalling theory, such firms may also use dividend payments as a way to signal financial strength and reliability under heightened scrutiny.

To test this idea, I estimate a triple-difference model that interacts the treatment effect (*Treated* × *After*) with firm-level carbon measures. All specifications include year, stock exchange, and industry fixed effects and cluster standard errors at the stock exchange level.

$$Y_{it} = \alpha + \beta_1.\ (Treated_i \times After_t \times Carbon_{it}) + \beta_2.\ (Treated_i \times After_t) + \beta_3.\ Treated_i + \beta_4.\ After_t + \beta_5\ .\boldsymbol{X}_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it} \quad (4\text{-}5)$$

I estimate specification (4-5) to examine the impact of the actual level of carbon emissions and carbon intensity on the treatment group following the regulation. $Carbon_{it}$ is the proxy variable for the actual level of firm-level emissions, i.e. total carbon emissions and carbon emissions scope 1 for models (1) and (2), respectively. The results of specification (4-5) are presented in Table 4-9. The Y_{it} is the main dependent variable, dividend payment for firm i in year t. The remaining variables are defined as outlined in Model (4-2).

[Table 4-9 about here]

Across all specifications, the triple-interaction coefficient is negative and statistically significant. Using continuous (logged) emissions, the estimates are -0.1813 for total emissions and -0.1278 for Scope 1. These results indicate that the positive effect of disclosure on payouts weakens and can even turn negative as carbon intensity rises. In other words, while mandatory disclosure increases dividends overall, the effect is much weaker for firms with high carbon emissions. The findings are consistent with recent studies showing that firms with higher carbon intensity face stronger financial constraints and adjust their financial strategies differently in response to regulation (Chang et al., 2024; Kovacs et al., 2021). They also complement evidence that ESG transparency is linked to higher dividends (Benlemlih, 2019; Fonseka & Richardson, 2023), but suggest that this relationship depends on firms' environmental profiles.

A key explanation is that these firms face competing financial demands. On the one hand, stronger monitoring and stakeholder pressure following disclosure increases the incentive to reassure investors through stable dividends (Benlemlih, 2019; La Porta et al., 2000). On the other hand, high-emission firms must conserve resources to meet compliance obligations, finance technological upgrades, and reduce reputational risk. Prior research shows that carbon-intensive firms face higher costs of capital (Bolton & Kacperczyk, 2021a), greater exposure to climate-policy shocks (Ilhan et al., 2021), and stronger investor scrutiny (Dyck et al., 2019), all of which constrain their ability to increase payouts. Another mechanism is the reallocation of financial resources toward green investment and innovation. Environmental regulation can stimulate the adoption of clean technology and green patenting, particularly in carbon-intensive industries (Aghion et al., 2016). Disclosure increases the visibility of environmental risks and reputational concerns, which may encourage managers to divert funds from shareholder distribution to low-carbon projects and sustainability initiatives (Cheng et al., 2014; Flammer et al., 2021). By doing so, high-emission firms attempt to lower future transition risks and strengthen legitimacy in the eyes of stakeholders (Krueger, 2015).

The analysis in Table 4-9 uses continuous measures of firms' carbon emissions to test whether the effect of mandatory disclosure on dividends depends on actual emissions levels. While this approach captures the variation in carbon intensity more precisely, it may also be sensitive to extreme values and measurement error. To complement this, I re-estimate the model by classifying firms into high- and low-emission groups using dummy variables, as reported in Table 4-10. In Model (1), the dummy equals one if a firm's emissions are above the sample median, and in Model (2), it equals one if the firm belongs to a high-emission industry, as shown in specification (4-6)

$$Y_{it} = \alpha + \beta_1. (Treated_i \times After_t \times High_{it}) + \beta_2. (Treated_i \times After_t) + \beta_3.Treated_i + \beta_4.After_t + \beta_5.\boldsymbol{X}_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it} \quad (4\text{-}6)$$

The specification (4-6) follows the same triple-differences framework but replaces the continuous emissions measure with binary indicators. By doing so, I can check whether the results are robust to alternative definitions of carbon intensity and whether the findings hold when comparing firms that are most clearly different in their emissions exposure. This step is consistent with prior studies that validate continuous results with categorical measures of environmental risk (e.g., Bolton & Kacperczyk, 2021a; Ilhan et al., 2021). As reported in Table 4-10, Model (1) defines the dummy as one if a firm's emissions are above the sample median, while Model (2) defines it as one if the firm operates in a high-emission industry.[16] In both models, the coefficients on the triple-interaction term (*Treated* × *After* × *High*) are negative and statistically significant: -0.5306 in Model (1) and -0.4075 in Model (2).

The results in Table 4-10 confirm the earlier evidence that the coefficients on the triple-interaction terms are negative and statistically significant across both models. This means that the positive effect of mandatory disclosure on dividends is consistently weaker for high-emission firms, whether emissions are measured as continuous variables or grouped into high/low categories. The consistency of these findings reinforces the interpretation that carbon intensity acts as an important moderating factor, which disclosure strengthens payouts overall,

[16] I classify the samples into two groups: high-emission and low-emission industries, following the approach used in previous studies (e.g., Zhu & Hou, 2022). Firms in the Chemicals, Construction Materials, Electric Utilities, Gas Utilities, Independent Power and Renewable Energy, Metals and Mining, Oil, Gas and Consumable Fuels, and Paper and Forest Products industries are classified as high-emission industries. All other firms are classified as low-emission industries.

but firms with higher emissions show a muted response, likely because of competing financial pressures related to compliance, reputational risk, and transition investment.

[Table 4-10 about here]

Overall, the results from Table 4-9 and Table 4-10 highlight that the carbon emissions factor matters for dividend policy. The positive impact of disclosure on dividends is stronger for low-emission firms, who may be more able to commit cash to shareholders, while high-emission firms show a more cautious payout response. This heterogeneity underscores that environmental characteristics play a key role in shaping how financial policies respond to sustainability regulation.

4.7.4 The effect of mandatory emissions disclosure on share repurchases

The baseline analysis demonstrates that mandatory carbon disclosure leads to a significant increase in dividend payouts, suggesting that firms respond to greater transparency by strengthening their commitment to shareholders. However, dividends are not the only one channel through which firms can return cash to investors. Another important payout mechanism is share repurchases, which have become increasingly popular as a flexible alternative to dividends in many markets (Brav et al., 2005; Farre-Mensa et al., 2014; Skinner, 2008). To ensure that the documented increase in dividends is not simply offset by substitution into buybacks or part of a broader shift in payout policy, it is necessary to examine whether the regulation also affects firms' share repurchase behaviour.

In addition to paying dividends, firms may also distribute value to shareholders through share repurchases. By reducing the number of shares in circulation, buybacks can increase earnings per share and, in many cases, enhance market valuation (Bonaimé, 2015; Brav et al., 2005). Over the past two decades, repurchases have become an increasingly important payout channel, sometimes even surpassing dividends in certain markets (Farre-Mensa et al., 2014; Skinner, 2008). Theories of payout policy suggest that firms may choose between dividends and repurchases depending on tax preferences, flexibility needs, and information considerations. For example, signalling models argue that managers may use repurchases to convey private information about undervaluation, while agency-based views highlight that repurchases, like dividends, can mitigate free cash flow problems (Jensen, 1986).

Given this background, it is important to test whether the positive effect of mandatory carbon disclosure on dividends examined earlier reflects a broader shift in payout policy or is specific to dividends. If investors in certain contexts prefer buybacks over dividends, one might expect disclosure regulation to influence repurchases as well. To examine this, I estimate the baseline difference-in-differences specification (4-2), using the ratio of repurchases to total assets as the dependent variable.

The results, reported in Table 4-11, show that the coefficient on the treatment effect (*Treated × After*) is small and statistically insignificant across all specifications. In Model (1), the estimate is 0.0613, in Model (2) it is 0.0552, and in Model (3) it is 0.0547, none of which reach conventional significance levels. These findings suggest that mandatory carbon disclosure does not have a systematic effect on firms' repurchase decisions. The absence of an effect on buybacks is consistent with prior research showing that dividends and repurchases, while both payout mechanisms, are not perfect substitutes. Dividends are viewed as a stronger commitment device to reduce agency costs and reassure investors (La Porta et al., 2000), while repurchases are often more opportunistic and flexible. From this perspective, the increase in dividends following disclosure may reflect the stronger role of dividends in addressing agency problems and information asymmetry under heightened scrutiny (Jensen, 1986), whereas repurchases play a weaker role in this regard. Overall, the results indicate that mandatory carbon disclosure leads to higher dividends but does not alter share repurchase behaviour. This distinction suggests that the regulation strengthens the use of dividends as a governance mechanism, rather than prompting a general increase in shareholder payouts across all forms.

4.8 Conclusion

This chapter examines how the introduction of mandatory carbon disclosure in the U.K. affected firms' dividend policies. The analysis is based on a sample of European companies covering the period 2009 to 2017. Using a difference-in-differences approach, the results show that firms subject to the regulation raised their dividend payouts significantly after the mandate came into effect. The effect is economically meaningful, translating into an 8.69% increase relative to the average firm; this corresponds to an average increase of about 22.48 USD million in dividend payments**.** The results remain robust to a wide range of checks, including placebo tests, alternative dividend measures, and additional controls, while evidence from share repurchases shows that the findings are not driven by substitution across payout channels. These results provide strong support for the hypothesis that mandatory carbon disclosure influences dividend policy.

Beyond the average treatment effect, I further explore the channels through which disclosure shapes payout decisions. The analysis shows that institutional ownership plays a central moderating role. Firms with higher levels of institutional ownership respond more strongly to disclosure by raising dividends, consistent with agency theory and monitoring-based perspectives, which emphasise the role of institutional investors in reducing managerial discretion. This pattern underscores the importance of governance structures in shaping how firms translate environmental transparency into financial commitments to shareholders.

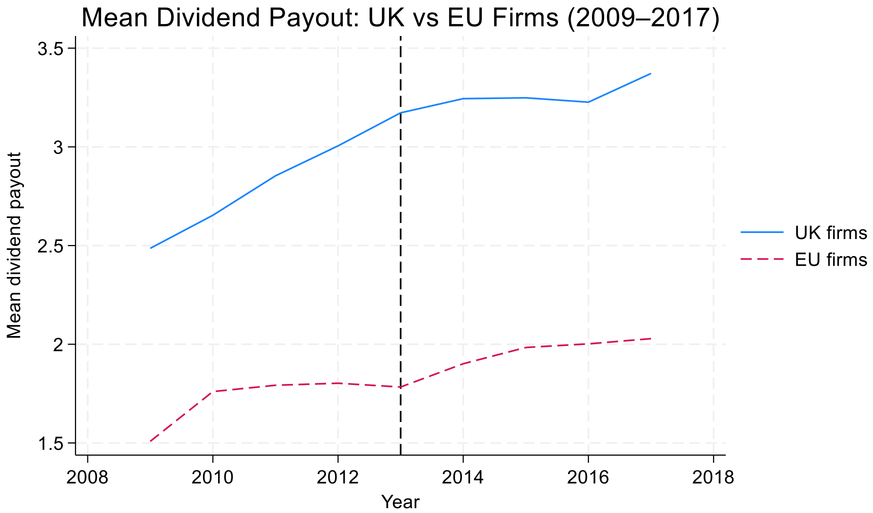
Additional evidence shows that the investment horizon of institutional investors further conditions these effects. Firms with greater long-term institutional ownership significantly increased dividends after the mandate, while those dominated by short-term investors displayed no systematic change. Long-term investors appear to amplify the disciplining effect of disclosure by pressing managers to distribute free cash flows and signal financial stability, which is in line with both agency and signalling theories. By contrast, short-term investors, who prioritise flexibility and immediate returns, exert weaker monitoring pressure and therefore do not reinforce the dividend response. This heterogeneity highlights that the effectiveness of disclosure mandates depends not only on the presence of institutional investors but also on their investment horizons.

The role of firms' environmental profiles is also evident. While mandatory disclosure generally leads to higher payouts, the positive effect is much weaker among firms with high carbon emissions. These firms face greater compliance costs, reputational risks, and transition pressures, limiting their ability to commit resources to shareholders. By contrast, low-emission firms respond more strongly by raising dividends, reflecting both lower financial constraints and the use of payouts to strengthen credibility under heightened scrutiny. This finding highlights that carbon intensity is a key boundary condition that shapes the financial consequences of disclosure regulation.

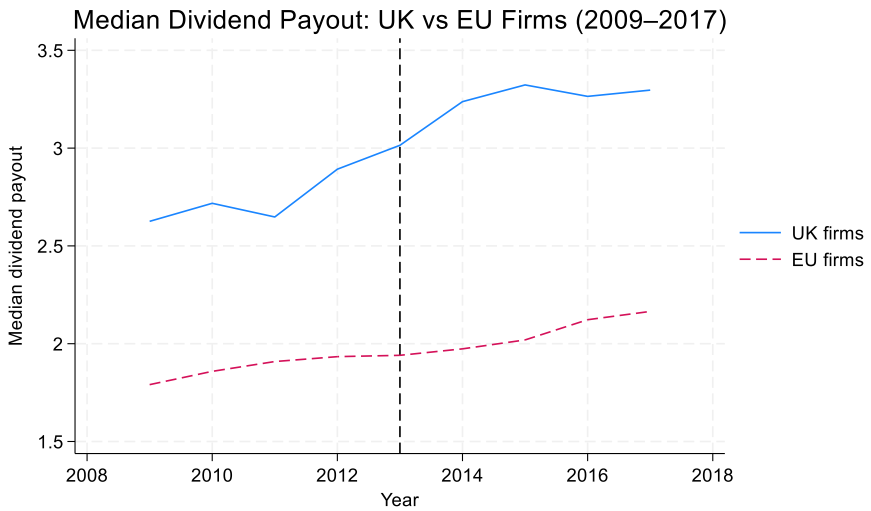
Overall, the results of this chapter demonstrate that mandatory carbon disclosure has significant implications for corporate payout policy, but that the effects vary across ownership structures, investor horizons, and emission profiles. For regulators, these findings suggest that disclosure mandates can strengthen financial discipline and investor confidence. However, their effectiveness is maximised in settings with long-term institutional ownership and low emissions exposure. For firms, the evidence shows that disclosure is more than a compliance requirement; it operates as a governance mechanism that reshapes financial strategies, enhances credibility with investors, and influences long-term positioning in capital markets.

Figure 4-1. Mean and Median of Dividend Payout: UK and EU Firms Before and After 2013

This figure reports the annual mean (Panel A) and median (Panel B) dividend payout ratios for U.K. and EU firms over the period 2009–2017. The dividend payout ratio is measured as dividends divided by total assets. The vertical line marks the introduction of the mandatory carbon disclosure regulation in the U.K. in 2013. The figure provides descriptive evidence on the time-series evolution of dividend policy for treated (U.K.) and control (EU) firms before and after the regulatory change.



Panel A: Mean dividend payout ratio



Panel B: Median dividend payout ratio

Figure 4-2 The differences in dividend payments between U.K. (treatment) and European (control) firms around the introduction of the regulation.

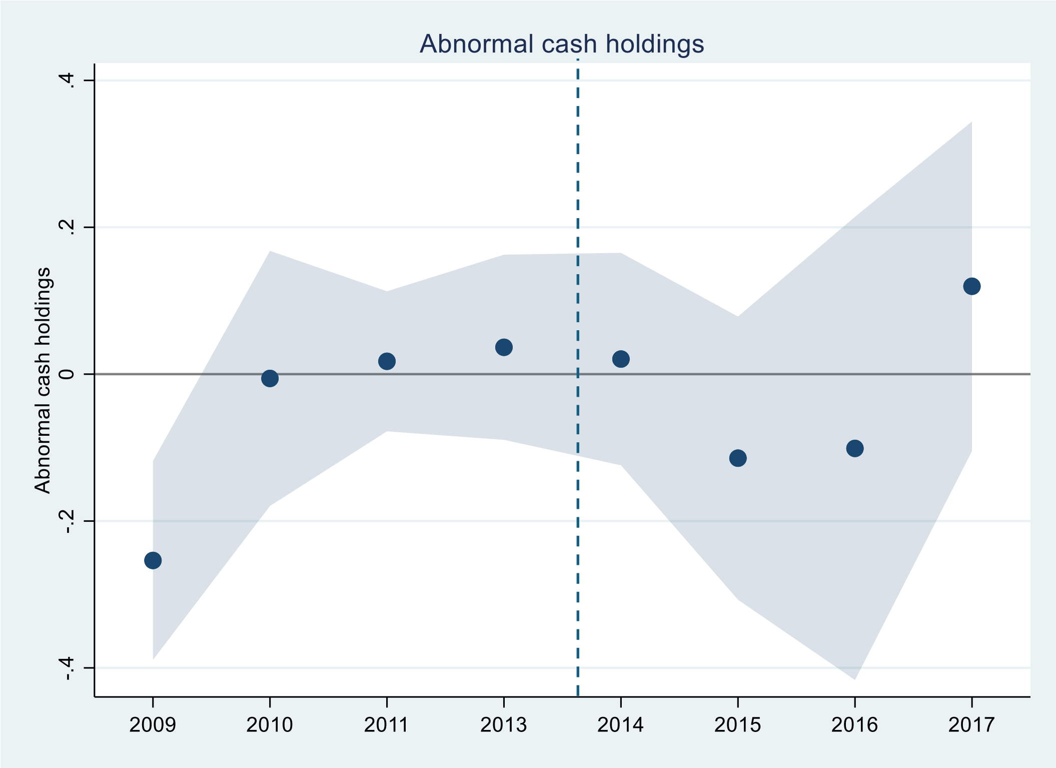


Figure 4-2 illustrates the parallel trend assumption test derived from the event-study regression. The coefficients plotted correspond to the interaction terms between the treatment group (U.K. firms) and each year, relative to the pre-policy base period. The shaded region represents the 95% confidence intervals. The results indicate that all pre-treatment coefficients (2010–2012) are statistically indistinguishable from zero and clustered closely around the horizontal axis. This pattern suggests that, before enacting the greenhouse gas (GHG) disclosure mandate, treated and control firms followed similar trajectories in dividend payout behaviour**.** Hence, the two groups had no significant differences in dividend trends before the policy change. These findings support the parallel trend assumption, which is a critical identifying condition for the Difference-in-Differences (DiD) estimation framework.

Tables of Chapter 4

Table 4-1 Sample selection

This table presents the sample selection procedure for the analysis of dividend payout policy. Financial firms (SIC 6000–6999) are excluded. The sample period is 2009–2017.

Step of sample selection procedure	Firms	Firm-year
All firm-year observations for listed firms in European countries from S&P Capital IQ (2009–2017)	6,951	62,559
Exclude financial firms (SIC 6000–6999)	5,855	52,695
Exclude firms that never pays dividends	2,992	26,928
Exclude firms with total assets < 100USD mm	1,838	16,542

Table 4-2 Summary statistics

Table 4-2 summarises the key variables employed in the analysis. Panel A presents the descriptive statistics, including the number of observations, average values, medians, standard deviations, and observed ranges (minimum and maximum). Panel B shows the correlation matrix, which highlights how the main variables are related to one another. The sample consists of European countries covering the years 2009–2017. To reduce the influence of outliers, all continuous measures are winsorized at the 1st and 99th percentiles. A full description of each variable is defined in Appendix 4-A1.

Variables	Obs.	Mean	Median	SD	min	max
Panel A: Descriptive statistics						
Main dependent variables:						
Div/total asset %	16502	1.791	1.1207	2.1329	0	7.9058
Carbon emissions variables (thousand tons)						
Total carbon intensity	7743	.3963	.2346	.4183	.0487	1.7263
Total carbon emissions (log)	7743	6.3785	6.2564	1.8688	3.0113	10.1908
Carbon Intensity Scope 1	7743	.2076	.0194	.6438	.0003	5.4686
Carbon Emissions Scope 1 (log)	7740	4.1077	3.8005	2.642	-1.9306	11.2938
Control variables						
Firm-level control variables						
Retained earnings/total assets	16496	.387	.3525	.4575	-.6959	1.3676
Leverage	16502	.5697	.5762	.1766	.2212	.8954
Cash ratio	16502	.108	.0818	.0881	.0073	.3436
ROA	16502	.0383	.0363	.0513	-.0952	.1517
Sales growth %	16542	4.9523	3.8429	14.4762	-38.7742	51.5827
Div(dummy)	16542	.6809	1	.4662	0	1
Institutional investor variable						
IO %	14863	31.0253	24.5155	24.8	.7638	88.4914
Additional variables						
Div/Earning %	16426	14.6196	11.9245	14.9699	0	52.6677
Div/Revenue %	16404	2.2558	1.198	2.8661	0	11.2665
Div 1 yr growth %	16542	6.593	0	19.1636	-50	100
Div (log)	10839	4.4128	4.3051	1.8823	.0629	9.409
RD expenditure	16502	.0141	0	.0325	0	.1972
Firm age	16083	73.8109	56	59.9676	0	328
GDP (log)	16533	10.5421	10.648	.5332	9.1064	11.4128
GDP growth %	16533	1.3169	1.6499	2.7257	-5.6938	11.2001
Inflation %	16533	1.6991	1.285	2.0383	-1.1439	11.144
Investor protection index (IPD)	16533	6.8474	7	2.6352	0	10

Panel B: Correlation matrix													
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Dividend ratio	1.0000												
(2) Retained earnings	0.1240	1.0000											
	(0.000)												
(3) Leverage	-0.2150	-0.0370	1.0000										
	(0.000)	(0.000)											
(4) Cash ratio	0.1780	-0.0330	-0.2260	1.0000									
	(0.000)	(0.000)	(0.000)										
(5) Sales growth	0.0170	-0.0090	-0.0230	0.0370	1.0000								
	(0.029)	(0.248)	(0.003)	(0.000)									
(6) ROA	0.5390	0.1560	-0.2790	0.1680	0.1910	1.0000							
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)								
(7) Div (dummy)	0.3830	0.1720	-0.1310	0.0350	0.0110	0.4150	1.0000						
	(0.000)	(0.000)	(0.000)	(0.000)	(0.169)	(0.000)							
(8) RD	0.1230	-0.0350	-0.1380	0.2880	0.0200	0.0720	0.0120	1.0000					
	(0.000)	(0.000)	(0.000)	(0.000)	(0.009)	(0.000)	(0.126)						
(9) Firm age	0.0280	0.1030	0.0580	-0.0800	-0.0920	0.0350	0.1880	-0.0390	1.0000				
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)					
(10) GDP per capita	0.0770	0.0420	0.0350	0.0630	-0.0330	0.0540	0.2080	0.1830	0.1830	1.0000			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)				
(11) GDP growth	0.0690	0.0180	-0.0800	0.0110	0.1660	0.1020	0.0290	0.0050	-0.0160	-0.1170	1.0000		
	(0.000)	(0.024)	(0.000)	(0.143)	(0.000)	(0.000)	(0.000)	(0.489)	(0.042)	(0.000)			
(12) Inflation	-0.0190	-0.0240	-0.0470	-0.0460	0.1600	0.0300	-0.1620	-0.0930	-0.1320	-0.4700	0.2120	1.0000	
	(0.016)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
(13) IPD	-0.0080	-0.0250	0.0680	-0.0860	0.0660	0.0140	-0.0260	-0.0970	-0.0970	-0.2550	0.1400	0.2700	1.0000
	(0.279)	(0.001)	(0.000)	(0.000)	(0.000)	(0.064)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	

Table 4-3 *Mandatory corporate carbon disclosure and dividend payout*

$$Y_{it} = \alpha + \beta_1.(Treated_i \times After_t) + \beta_2 Treated_i + \beta_3 After_t + \beta_4 X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

Y_{it} represents the dependent variable, measured as the dividend payout ratio (common dividends declared divided by total assets) for firm *i* in year *t*. The variable $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes lagged firm-level controls. The definitions are described in Appendix 4-A1. Year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects are included. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. The sample period spans 2009–2017. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively.

Dependent: Dividend payout ratio			
	(1)	(2)	(3)
DiD (Treated × After)	0.2863***	0.2292***	0.2364***
	(4.1828)	(4.1006)	(4.5259)
Treated	0.9826***	0.7530**	0.5772**
	(3.4163)	(2.5369)	(2.1181)
After	-0.0384	-0.0316	-0.0645
	(-0.2917)	(-0.2711)	(-0.5856)
Retained earnings		0.1127***	0.0661**
		(3.0665)	(2.0565)
Leverage		-0.5833***	-0.3379
		(-2.8275)	(-1.5621)
Cash ratio		2.2553***	2.3134***
		(7.1784)	(8.3129)
Sales growth		-0.0072***	-0.0068***
		(-4.6193)	(-4.6609)
ROA		16.9598***	14.4545***
		(15.9933)	(13.0689)
Div (dummy)			1.1054***
			(9.1110)
Constant	1.8682***	1.3561***	0.6081***
	(25.6843)	(10.4510)	(3.8069)
Observations	16,502	16,425	16,425
R-squared	0.2756	0.4407	0.4624
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Stock exchange FE	Yes	Yes	Yes

Table 4-4: Robustness check – Omitted Variable bias

This table presents the results of the Difference-in-Differences (DiD) analysis used to conduct omitted Variable bias, following the empirical specification below:

$$Y_{it} = \alpha + \beta_1.(Treated_i \times After_t) + \beta_2 Treated_i + \beta_3 After_t + \beta_4 X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

where Y_{it} represents the dependent variable, defined as the dividend payout ratio (dividends scaled by total assets) for firm *i* in year *t*. The coefficient of interest, β_1, captures the DiD estimator, represented by the interaction term $(Treated_i \times After_t)$. *Treated*$_i$ is a dummy variable equal to one for firms listed in the LSE and zero otherwise. *After*$_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. X_{it-1} denotes a vector of one-year-lagged control variables, including firm-level factors (Retained earnings, Leverage, Cash ratio, Sales growth, ROA, and Div), and additional control variables are also incorporated: RD**,** Firm age**,** GDP per capita, GDP growth, Inflation, and Investor protection index (IPD) as defined in Appendix 4-A1**.** Year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects are included. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The sample period spans 2009–2017.

Dependent variable: Dividend payout ratio	
	(1)
DiD (Treated × After)	0.2378***
	(3.6899)
Treated	0.6080**
	(2.1237)
After	-0.0757
	(-0.7001)
Retained earnings	0.0626**
	(2.0521)
Leverage	-0.2791
	(-1.4085)
Cash ratio	2.0255***
	(7.4860)
Sales growth	-0.0070***
	(-4.7303)
ROA	14.5489***
	(12.8898)
Div (dummy)	1.1338***
	(8.9765)
RD	7.2378***
	(3.3551)
Firm age	-0.0009
	(-0.8946)
GDP per capita	0.4666
	(0.9058)
GDP growth	0.0005
	(0.0314)

Dependent variable: Dividend payout ratio	
	(1)
Inflation	0.0156
	(0.5987)
IPD	0.0717*
	(1.7954)
Constant	-4.8827
	(-0.8741)
Observations	15,962
R-squared	0.4674
Industry FE	Yes
Year FE	Yes
Stock exchange FE	Yes

Table 4-5: Robustness Check – Random Assignment of Treatment and Control Groups

This table presents the results of a Difference-in-Differences (DiD) analysis used as a robustness check, following the empirical specification below:

$$Y_{it} = \alpha + \beta_1(Treated_i \times After_t) + \beta_2 Treated_i + \beta_3 After_t + \beta_4 X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

where Y_{it} represents the dependent variable, measured as the dividend payout ratio (dividends scaled by total assets) for firm i in year t. The key variable of interest, $(Treated_i \times After_t)$, captures the DiD estimator. *$Treated_i$ is a randomly assigned dummy variable, taking the value of one for firms in the random treatment group and zero otherwise.* This approach tests whether the main findings are driven by chance rather than the actual regulatory effect. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. X_{it-1} denotes a vector of lagged control variables. All variable definitions are provided in Appendix 4-A1. Year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects are included. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The sample period spans 2009–2017.

Dependent variable: Dividend payout ratio					
	(1) treated_fake1	(2) treated_fake2	(3) treated_fake3	(4) treated_fake4	(5) treated_fake5
DiD (Treated × After)	-0.0270				
	(-0.3637)				
DiD (Treated × After)		0.0113			
		(0.1741)			
DiD (Treated × After)			0.0634		
			(1.1139)		
DiD (Treated × After)				0.0324	
				(0.3631)	
DiD (Treated × After)					0.0993
					(0.8353)
Retained earnings	0.0677**	0.0672**	0.0671**	0.0664**	0.0668**
	(2.1515)	(2.1074)	(2.1288)	(2.1190)	(2.1419)
Leverage	-0.2946	-0.2977	-0.2916	-0.2967	-0.2928
	(-1.4396)	(-1.4907)	(-1.4440)	(-1.4598)	(-1.4551)
Cash ratio	2.3071***	2.3153***	2.3077***	2.3099***	2.3260***
	(8.1853)	(8.4269)	(8.3875)	(8.3063)	(8.2484)
Sales growth	-0.0069***	-0.0069***	-0.0069***	-0.0069***	-0.0069***
	(-4.7740)	(-4.7658)	(-4.7714)	(-4.7711)	(-4.8007)
ROA	14.5223***	14.5212***	14.5226***	14.5082***	14.5257***
	(13.2434)	(13.2265)	(13.2530)	(13.2706)	(13.2770)
Div (dummy)	1.1285***	1.1309***	1.1293***	1.1317***	1.1260***
	(9.2601)	(9.2046)	(9.2451)	(9.2903)	(9.1978)
Observations	16,425	16,425	16,425	16,425	16,425
R-squared	0.4604	0.4610	0.4604	0.4604	0.4605
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Stock exchange FE	Yes	Yes	Yes	Yes	Yes

Table 4-6: Robustness Check – Alternative Measures of Dividend Ratio

This table presents the results of a Difference-in-Differences (DiD) analysis that tests the robustness of the main findings using alternative measures of dividend policy. The model is estimated as follows:

$$Y_{it} = \alpha + \beta_1(Treated_i \times After_t) + \beta_2 Treated_i + \beta_3 After_t + \beta_4 X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

where Y_{it} represents alternative proxies for dividend policy for firm *i* in year *t*. Specifically, the dependent variables include dividends-to-sales (Div/Sales), dividends-to-earnings (Div/Earnings), the natural logarithm of total dividends, and one-year dividend growth rate. These measures provide complementary perspectives on firms' payout behaviour and ensure that the results are not sensitive to a single definition of dividend policy. The variable $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} denotes lagged firm-level controls. Definitions of all variables are detailed in Table 4-A1. The model includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The sample period spans 2009–2017.

	(1) Div/sale	(2) Div/earnings	(3) Div (log)	(4) Div 1 yr growth
DiD (Treated × After)	0.4078***	1.2331***	0.1497***	1.9413*
	(4.7801)	(3.8457)	(4.2016)	(1.8784)
Treated	0.6079***	3.3143***	0.8337	-3.0426***
	(2.8556)	(2.9822)	(1.4578)	(-2.8487)
After	-0.1831	-0.5221	0.1649**	-3.7784**
	(-1.2628)	(-0.6769)	(2.4844)	(-2.5531)
Retained earnings	0.1467***	0.7054***	0.1929***	-0.5342**
	(3.1165)	(3.6043)	(3.0252)	(-2.1640)
Leverage	-1.4056***	-5.7525***	1.9296***	-2.2904
	(-3.9307)	(-5.7949)	(8.1437)	(-1.4323)
Cash ratio	1.8140***	8.4766***	-0.3268	3.4109
	(4.5167)	(4.3818)	(-0.5513)	(1.4920)
Sales growth	-0.0094***	-0.0327***	-0.0054***	0.0307**
	(-4.7788)	(-4.0475)	(-5.0736)	(2.3128)
ROA	13.1362***	39.4040***	5.6697***	-31.9735***
	(13.1363)	(9.6994)	(8.8768)	(-2.8353)
Dividend (Dummy)	1.6370***	11.3277***	0.6001***	16.1149***
	(14.7474)	(16.5260)	(10.0639)	(11.6562)
Observations	16,329	16,357	10,823	16,437
R-squared	0.3879	0.4442	0.4848	0.0769
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Stock exchange FE	Yes	Yes	Yes	Yes

Table 4-7: Impact of mandatory carbon disclosure on dividend policy – Institutional ownership effect

This table presents the results of the Double Difference-in-Differences (DiDiD) analysis. The estimation follows the specification below:

$$Y_{it} = \alpha + \beta_1(Treated_i \times After_t \times IO_{it}) + \beta_2(Treated_i \times After_t) + \beta_3 Treated_i + \beta_4 After_t + \beta_5 X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

where Y_{it} denotes the dividend payout ratio (dividends scaled by total assets) for firm *i* in year *t*, representing the firm's dividend policy. The coefficient of interest, β_1, corresponds to the triple interaction term ($Treated_i \times After_t \times IO_{it}$), which captures how the regulatory effect on dividend policy differs across levels of institutional ownership. IO_{it} measures the percentage of shares held by institutional investors in firm i at time t. The variable $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} denotes lagged firm-level controls. Definitions of all variables are detailed in Table 4-A1. The model includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The sample period spans 2009–2017.

Dependent variable: Dividend payout ratio	(1)	(2)	(3)
DiDiD ($Treated_i \times After_t \times IO_{it}$)	0.0244***	0.0317***	0.0241***
	(7.3035)	(29.3533)	(8.3471)
DiD ($Treated_i \times After_t$)	-1.6092***	-2.2018***	-1.6143***
	(-6.4222)	(-24.0290)	(-7.6312)
Treated	0.5935**	0.7131***	0.4200***
	(2.0587)	(3.2403)	(2.7824)
After	-0.0795	-0.0665	0.0346
	(-0.7383)	(-0.6401)	(0.3252)
Retained earnings	0.0765**	0.0531	0.0964**
	(2.0569)	(1.6232)	(2.5601)
Leverage	-0.4123*	-0.6503***	-0.7111***
	(-1.7235)	(-2.8249)	(-2.9326)
Cash ratio	2.2731***	2.6059***	1.9575***
	(7.2899)	(6.0248)	(5.1087)
Sales growth	-0.0076***	-0.0096***	-0.0076***
	(-4.7249)	(-5.6416)	(-4.4644)
ROA	14.9782***	18.1689***	15.8758***
	(12.2771)	(11.8428)	(12.5388)
Div (dummy)	1.0673***	1.0214***	0.9590***
	(8.6324)	(7.8495)	(6.3984)
Constant	0.7010***	0.7076***	0.8993***
	(3.7850)	(3.6428)	(4.0281)
Observations	14,855	14,856	14,855
R-squared	0.4772	0.3836	0.4488
Industry FE	Yes	No	Yes
Year FE	Yes	Yes	Yes
Stock exchange FE	Yes	Yes	No

Table 4-8: Impact of Mandatory Carbon Disclosure on Dividend Policy – Investment Horizon Effect

This table presents the results of a Double Difference-in-Differences (DiDiD) analysis. The estimation follows the specification below:

$$Y_{it} = \alpha + \beta_1(Treated_i \times After_t \times Type_{it}) + \beta_2(Treated_i \times After_t) + \beta_3 Treated_i + \beta_4 After_t + \beta_5 X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

where Y_{it} denotes the dividend payout ratio (dividends scaled by total assets) for firm *i* in year *t*. The coefficient of interest, β_1, corresponds to the triple interaction term $(Treated_i \times After_t \times Type_{it})$. $Type_{it}$ represents a proxy variable that is the proportion of shares held by long-term or short-term institutional investors, distinguishing their investment horizons. $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} denotes lagged firm-level controls. Definitions of all variables are detailed in Table 4-A1. The model includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The sample period spans 2009–2017.

Dependent variable: Dividend payout ratio		
	Long-term institutional ownership	Short-term institutional ownership
	(1)	(2)
DiDiD (Treated × After × Type)	0.0262***	-0.0279
	(8.9078)	(-1.4863)
DiD $(Treated_i \times After_t)$	-1.6905***	0.3147***
	(-7.1090)	(3.2558)
Treated	0.5959***	0.6290***
	(5.4815)	(3.6189)
After	-0.0722	0.0226
	(-0.6878)	(0.1216)
Retained earnings	0.0759***	0.0460
	(3.4424)	(1.4322)
Leverage	-0.4151***	-0.9450***
	(-3.3257)	(-4.0159)
Cash ratio	2.2831***	2.5415***
	(10.2681)	(6.1899)
Sales growth	-0.0076***	-0.0085***
	(-6.9837)	(-5.1045)
ROA	14.9937***	14.8979***
	(23.6669)	(16.8511)
Dividend (Dummy)	1.0653***	1.4359***
	(18.7141)	(15.8593)
Observations	14,843	7,059
R-squared	0.4776	0.5170
Industry FE	Yes	Yes
Year FE	Yes	Yes
Stock exchange FE	Yes	Yes

Table 4-9: Impact of mandatory carbon disclosure on dividend policy – Carbon emissions effect

This table reports the results of a double difference-in-differences (DiDiD) analysis, estimated according to the specification outlined below.

$$Y_{it}=\alpha + \beta_1.(Treated_i \times After_t \times Carbon_{it}) + \beta_2.(Treated_i \times After_t) + \beta_3.Treated_i + \beta_4.After_t + \beta_5.\mathbf{X}_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

where Y_{it} is the main dependent variable, that is, dividend payout ratio (Div/total asset) for firm i in year t. The DiDiD is the interesting variable that is the interaction among $Treated_i$, $After_t$ and $Carbon_{it}$. $Carbon_{it}$ is the proxy variable for the actual level of firm-level emissions, i.e. total carbon emissions, and carbon emissions scope 1 for models (1) and (2), respectively. $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} denotes lagged firm-level controls. Definitions of all variables are detailed in Table 4-A1. The model includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The sample period spans 2009–2017.

Dependent variable: Dividend payout ratio		
	Carbon emissions (log)	
	(1)	(2)
	Total emissions	Emissions scope1
DiDiD ($Treated_i \times After_t \times Carbon_{it}$)	-0.1813***	-0.1278***
	(-9.8080)	(-5.2717)
DiD ($Treated_i \times After_t$)	1.2897***	0.6446***
	(7.3618)	(4.1519)
Treated	0.2636	0.2716
	(0.6112)	(0.6281)
After	-0.0008	-0.0015
	(-0.0047)	(-0.0091)
Retained earnings	0.0019	0.0025
	(0.0562)	(0.0772)
Leverage	-0.5087	-0.5050
	(-1.6258)	(-1.6079)
Cash ratio	2.9471***	2.9401***
	(5.2839)	(5.3165)
Sales growth	-0.0123***	-0.0124***
	(-5.6471)	(-5.7855)
ROA	16.8127***	16.8331***
	(11.2243)	(11.2511)
Dividend (Dummy)	1.2909***	1.2893***
	(6.9369)	(6.9592)
Observations	7,737	7,734
R-squared	0.5187	0.5187
Industry FE	Yes	Yes
Year FE	Yes	Yes
Stock-exchange FE	Yes	Yes

Table 4-10: Impact of mandatory carbon disclosure on dividend policy – Industry effect

This table reports the results of double difference-in-differences (DiDiD) analysis, estimated according to the specification outlined below.

$$Y_{it}=\alpha + \beta_1.(Treated_i \times After_t \times High_{it}) + \beta_2.(Treated_i \times After_t) + \beta_3.Treated_i + \beta_4.After_t + \beta_5.\boldsymbol{X}_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

where Y_{it} is the main dependent variable, that is, dividend payout ratio (Div/total asset) for firm i in year t. The DiDiD is the interesting variable that is the interaction among $Treated_i$, $After_t$, and $High_{it}$. $High_{it}$ in the model (1) is the dummy variable that takes the value of 1 if the firm emits an emission intensity higher than the median and zero otherwise. $High_{it}$ in the model (2) is the dummy variable that takes the value of 1 if the firm is categorised as a high emissions industry firm and zero otherwise. $Treated_i$ is a dummy = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} denotes lagged firm-level controls. Definitions of all variables are detailed in Table 4-A1. The model includes year **(γ_t)**, industry **(τ_j)**, and stock exchange **(λ_s)** fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The sample period spans 2009–2017.

Dependent variable: Dividend payout ratio		
	(1) High carbon emissions (dummy)	(2) High emissions industry (dummy)
DiDiD	-0.5306***	-0.4075**
	(-16.5125)	(-2.4105)
DiD ($Treated_i \times After_t$)	0.4043***	0.2973***
	(3.5270)	(4.8929)
Treated	0.4651	0.5844**
	(1.4872)	(2.1505)
After	0.0178	-0.0657
	(0.1200)	(-0.5973)
Retained earnings	-0.0227	0.0668**
	(-0.9412)	(2.0892)
Leverage	-0.6729**	-0.3383
	(-2.4078)	(-1.5667)
Cash ratio	2.7854***	2.3125***
	(5.3059)	(8.2984)
Sales growth	-0.0156***	-0.0068***
	(-6.5246)	(-4.6762)
ROA	21.9107***	14.4490***
	(12.9766)	(13.0571)
Dividend (Dummy)	1.1248***	1.1051***
	(5.7332)	(9.1172)
Observations	7,734	16,425
R-squared	0.4052	0.4625
Industry FE	Yes	Yes
Year FE	Yes	Yes
Stock exchange FE	Yes	Yes

Table 4-11 The impact of mandatory carbon disclosure on share repurchases

This table reports the results of the Difference-in-Differences (DiD) analysis, estimated according to the specification outlined below.

$$Y_{it} = \alpha + \beta_1.(Treated_i \times After_t) + \beta_2 Treated_i + \beta_3 After_t + \beta_4 X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

where Y_{it} is the dependent variable, which is the repurchase declared/total asset for firm i in year t. $Treated_i$ is a dummy variable = 1 for U.K. firms subject to the disclosure requirement; 0 otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} denotes lagged firm-level controls. Definitions of all variables are detailed in Table 4-A1. The model includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects are included. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The sample period spans 2009–2017.

Dependent variable: Rep/total assets	(1)	(2)	(3)
DiD (Treated*After)	0.0613	0.0552	0.0547
	(1.4032)	(1.2614)	(1.2502)
Treated	-0.0302	-0.0810	-0.0678
	(-0.1539)	(-0.4293)	(-0.3650)
After	0.0684	0.0635	0.0660
	(0.8448)	(0.7534)	(0.7868)
Retained earnings		0.0121	0.0156
		(0.6623)	(0.9342)
Leverage		-0.0384	-0.0569
		(-0.3344)	(-0.4927)
Cash ratio		1.1127***	1.1084***
		(3.7726)	(3.7936)
Sales growth		-0.0017**	-0.0017**
		(-2.2650)	(-2.3133)
ROA		3.4020***	3.5902***
		(4.6077)	(4.8649)
Div (dummy)			-0.0831
			(-1.5300)
Constant	0.3758***	0.1639	0.1639
	(6.6625)	(1.4442)	(1.4442)
Observations	16,502	16,425	16,425
R-squared	0.1759	0.2035	0.2039
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Stock exchange FE	Yes	Yes	Yes

Appendix to Chapter 4

Table 4-A1: Variable Definitions

Variable	Description	Data source
Dependent variable: Main measure		
Div/total assets	The percentage ratio of total common cash dividends declared to the firm's total assets.	S&P Capital IQ
Key DiD variables		
Treated	A treatment indicator equal to one for firms subject to the U.K. mandatory carbon disclosure regulation (The Companies Act 2006 – Strategic Report and Directors' Report Regulations 2013) and zero otherwise.	Derived from the London Stock Exchange website
After	A post-treatment indicator that captures the period in which the regulation became effective. It takes the value of one from 2013 for firms with fiscal years ending on or after 30 September, and one from 2014 for firms with earlier fiscal year ends, consistent with the compliance timeline of the U.K. GHG disclosure mandate (Jouvenot & Krueger, 2019).	Derived from S&P Capital IQ
Type	The variable Type serves as a proxy, representing the actual percentage of firm-level ownership held by either long-term or short-term institutional investors.	Constructed
IO	The actual level of firm-level percentage ownership held by institutional investors.	S&P Capital IQ
Carbon	The actual carbon intensity of firm i in fiscal year t, representing the amount of greenhouse gas (GHG) emissions in thousand tons of CO_2 equivalent relative to the firm's revenue in mm USD.	Derived from S&P Capital IQ
High	A proxy dummy variable that takes the value of 1 if the firm emits an emission intensity higher than the median and zero otherwise, and takes the value of 1 if the firm is categorised as a high emissions industry firm and zero otherwise.	Derived from S&P Capital IQ
Firm-level control variables		
Retained Earnings	The ratio of retained earnings to total assets in US dollars.	S&P Capital IQ
Leverage	The ratio of total debt to total assets in US dollars.	S&P Capital IQ
Cash ratio	The ratio of cash and short-term investments to total assets in US dollars.	S&P Capital IQ
Sales growth	The percentage of sales or revenue growth is computed as (the sales of the current period - the sales of the previous period)/the sales of the previous period.	Derived from S&P Capital IQ
ROA	The ratio of net income scaled by the book value of total assets in US dollars.	S&P Capital IQ
Div (dummy)	The variable that equals one is if a firm pays a cash dividend in year t, and zero is otherwise.	Derived from S&P Capital IQ
RD	The ratio of R&D expenses scaled by total assets in US dollars.	S&P Capital IQ

Variable	Description	Data source
Firm age	The number of years since the firm's incorporation or listing.	Refinitiv
Additional variables		
Div/Earning %	The percentage ratio of common dividend declared to EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortisation).	Derived from S&P Capital IQ
Div/Revenue %	The percentage ratio of common dividends declared to total sales or revenues.	Derived from S&P Capital IQ
Div 1 yr growth %	The percentage of the year-on-year growth rate in the common dividend declared.	Derived from S&P Capital IQ
Div (log)	Natural logarithm of the common dividend declared in US dollars.	Derived from S&P Capital IQ
Rep/total assets	The percentage ratio of total repurchases declared to the firm's total assets.	Derived from S&P Capital IQ
Country-level control variables		
GDP (log)	Natural logarithm of gross domestic product per capita in US dollars.	Worldwide Governance Indicators data (WORLD BANK)
GDP growth	Annual percentage growth rate of GDP per capita.	Worldwide Governance Indicators data (WORLD BANK)
Inflation	Annual consumer price index.	Worldwide Governance Indicators data (WORLD BANK)
Investor protection index (IPD)	Ranges from 0 to 10. The investor protection index shows the legal protection for investors in different countries. (Bilyay-Erdogan et al., 2023)	Worldwide Governance Indicators data (WORLD BANK)

Table 4-A2: Parallel trend assumption

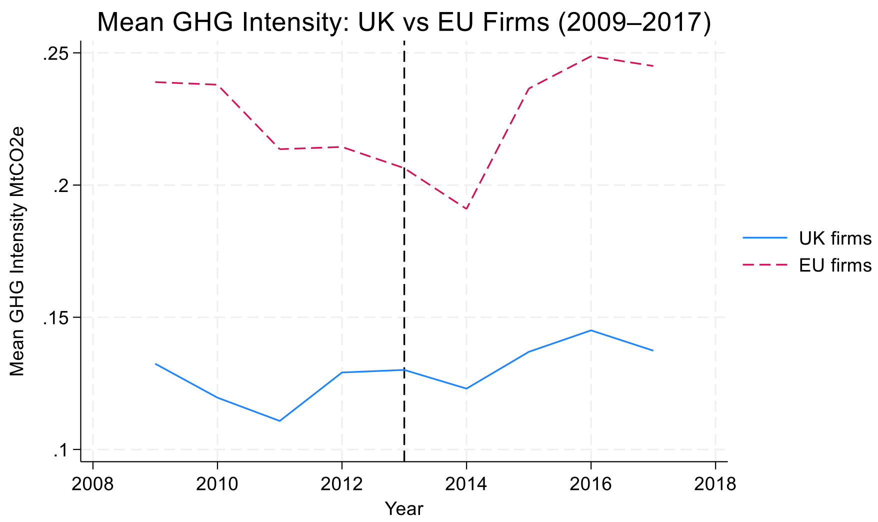
Dynamics of the Effect of The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013 on Dividend payout.

This table shows DID estimates of the effect of The Companies Act 2006 (Strategic Report and Directors Report) Regulations 2013 on Dividend payout for three years before and after the regulation period. The dependent variable is dividend payout which is calculated as the ratio of common dividends declared on total assets. Treated is an indicator dummy variable that takes the value of one for firms that are affected by the U.K. Year = t are year dummies. Treated × Year = t are interaction terms between the treatment dummy and the respective year dummies. The base year is 2012, which is why the year dummy and the interaction term for this year are dropped. T-stats are presented in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% significance levels, respectively. The empirical analysis covers the period 2009–2017.

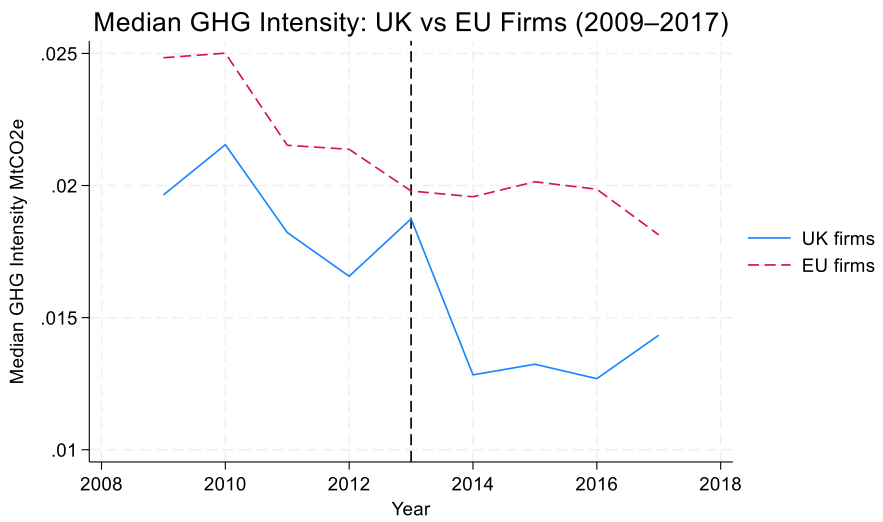
	(1)
Treated × Year = 2009	-0.1912**
	(-2.6932)
Treated × Year = 2010	0.0199
	(0.2386)
Treated × Year = 2011	0.0235
	(0.6331)
Treated × Year = 2012	0.0000
	(.)
Treated × Year = 2013	0.0421
	(0.7218)
Treated × Year = 2014	0.0135
	(0.1901)
Treated × Year = 2015	-0.0758
	(-0.8843)
Treated × Year = 2016	-0.0120
	(-0.1271)
Treated × Year = 2017	0.1471
	(1.4821)
DiD (Treated × After)	0.1797***
	(2.9260)
Observations	16,425
R-squared	0.4625
Controls	Yes
FE	Yes

Figure 4-A1 Distribution of Scope 1 Carbon Intensity: U.K. and EU Firms

This figure reports the annual mean (Panel A) and median (Panel B) Scope 1 GHG emissions intensity for U.K. and EU firms over the sample period (2009-2017). Carbon intensity is measured as Scope 1 GHG emissions scaled by firm revenue (as defined in Appendix A). The figure provides descriptive evidence on the evolution of firms' direct carbon exposure and allows for comparison between treated and control firms around the 2013 regulatory reform.



Panel A: Mean GHG intensity



Panel B: Median GHG intensity

Figure 4-A1 presents the annual mean (Panel A) and median (Panel B) Scope 1 GHG emissions intensity for U.K. and EU firms over the sample period. Carbon intensity is measured as Scope 1 GHG emissions scaled by firm revenue. The vertical line marks the introduction of mandatory carbon disclosure in the U.K. in 2013. Prior to the implementation of the regulation, I observe broadly comparable trends in carbon intensity between U.K. and EU firms. Both the mean and median values evolve in a relatively parallel manner, suggesting that treated and control firms exhibited similar environmental performance before the policy change.

Before 2013, I observe that U.K. and EU firms follow broadly similar trends in both mean and median Scope 1 emissions intensity. The two series move closely together, with no clear divergence. An exception appears in 2012, when emissions intensity for treated firms increases (Panel B). This increase may reflect firms beginning to measure and report their emissions more accurately in anticipation of the regulation, following clearer guidance on how emissions should be calculated.

Following the introduction of mandatory disclosure, a clear decline in Scope 1 carbon intensity becomes visible among U.K. firms relative to EU firms. Importantly, the reduction is more pronounced in the median (Panel B) than in the mean (Panel A). The sharper decline in the median suggests that the adjustment is not driven solely by a small number of extreme high-emission firms. Instead, it indicates that the typical treated firm reduces emissions intensity substantially after the regulation. While the mean also declines, its adjustment is comparatively smoother. This difference between mean and median implies that the distribution of emissions intensity shifts downward more broadly across firms, rather than being concentrated among a few outliers. The timing of the decline, occurring after 2013 and persisting in subsequent years, is consistent with firms progressively responding to enhanced transparency and regulatory scrutiny.

Chapter 5: Mandatory Carbon Disclosure and Abnormal Cash Holdings

5.1 Introduction

Carbon emissions are increasingly central to research on corporate decision-making because of their wide-ranging consequences for the global economy and the environment. In particular, firm-level emissions are now recognised as a major driver of climate change, due to their substantial contribution to rising greenhouse gas (GHG) concentrations (Amin et al., 2024). In response to this challenge, policymakers have introduced a variety of measures to curb emissions. These include regulatory approaches, such as mandatory carbon disclosure, as well as market-based instruments, such as carbon pricing and tax incentives designed to encourage investment in renewable energy and low-carbon technologies.

While a growing body of research examines how capital markets and external stakeholders react to disclosure regulations,[17] relatively little attention has been paid to their influence on corporate financial strategies. This chapter addresses this gap by investigating how carbon disclosure requirements shape abnormal cash holdings, defined as deviations from optimal liquidity levels. This focus complements my preceding empirical chapter, which examined the impact of mandatory disclosure on dividend payouts, by shifting the lens from external shareholder commitments to internal liquidity management.

Dividend policies reflect firms' outward commitments to shareholders and are often used to mitigate agency conflicts by distributing excess resources (Baker & Wurgler, 2004; Fonseka & Richardson, 2023; Jensen, 1986). Cash holdings, however, capture a more discretionary aspect of financial policy. Abnormal cash levels, whether excess reserves or

[17] See, for instance, (Bolton et al., 2021; X. Chen et al., 2024; Gibbons, 2020; Grewal, 2017; Grewal et al., 2019; Ioannou & Serafeim, 2017; Jayaraman & Wu, 2019; Jouvenot & Krueger, 2019; Krueger et al., 2021)

insufficient liquidity, signal managerial choices shaped by both precautionary motives (Bates et al., 2009; Opler et al., 1999) and agency-driven tendencies to hoard cash (Dittmar & Mahrt-Smith, 2007; Harford et al., 2008). Importantly, prior evidence shows that cash holdings and dividend policies are not simple substitutes; instead, they respond differently to governance mechanisms and external shocks (e.g. Al-Najjar & Belghitar, 2011; Pinkowitz et al., 2012). Studying abnormal cash holdings, therefore, provides a distinct perspective on how environmental disclosure influences corporate liquidity management.

Theoretical arguments suggest competing effects of mandatory disclosure on cash policies. From a precautionary standpoint, greater regulatory uncertainty and adaptation costs may prompt firms, especially high emitters, to accumulate larger reserves as a buffer (Azar et al., 2021; Bolton & Kacperczyk, 2021a; Han & Qiu, 2007). Conversely, agency theory predicts that increased transparency disciplines managers by exposing liquidity choices to external scrutiny, thereby curbing excess cash accumulation (Harford et al., 2008; Jensen, 1986). These contrasting predictions highlight the importance of examining whether carbon disclosure reduces abnormal cash through enhanced governance or increases it through heightened uncertainty.

The literature also emphasises the role of institutional ownership as an external governance mechanism that constrains managerial discretion over liquidity. Empirical evidence shows that firms with higher institutional ownership generally maintain lower excess cash, reflecting the ability of investors to discipline managers and discourage resource hoarding for private benefit (Dittmar et al., 2003; Harford et al., 2008). Institutional investors promote the efficient use of cash by pressuring firms to return resources to shareholders or to invest in value-enhancing opportunities (Ferreira & Vilela, 2004; Pinkowitz et al., 2006). However, the influence of institutions is not uniform. Long-term, monitoring-oriented investors are typically associated with lower cash holdings due to stronger oversight, whereas transient or passive institutional investors may exert weaker discipline (Gaspar et al., 2005; Harford et al., 2018). Recent studies further suggest that institutional investors adjust their influence in response to external shocks such as financial crises or environmental regulations, encouraging precautionary cash accumulation only when justified by heightened risk (Gao et al., 2013; Pinkowitz et al., 2012). Overall, institutional ownership tends to align liquidity management with shareholder value by limiting agency-driven hoarding and promoting cash policies consistent with governance quality and risk exposure. These insights suggest that the interaction between disclosure regulation and institutional ownership is critical for understanding cash management outcomes.

To test empirically how mandatory carbon disclosure influences abnormal cash holdings, I employ the introduction of the U.K.'s mandatory carbon disclosure regulation in September 2013 as a quasi-natural experiment. Using a dataset of 14,632 firm-year observations from 2008 to 2018 across European stock exchanges, I employ a difference-in-differences (DiD) approach to identify causal effects. Specifically, the analysis compares changes in abnormal cash holdings between U.K. firms (the treatment group) and firms from other European countries (the control group) across two periods, the pre-regulation years (2008–2012) and the post-regulation years (2013–2018). The U.K. regulation offers a valuable setting, as prior studies demonstrate its significant impact on financial performance and managerial decisions (Downar et al., 2021; Gerged et al., 2021; Jouvenot & Krueger, 2019). This empirical framework, therefore, allows me to examine how mandatory carbon disclosure influences abnormal cash holdings, including both excess liquidity and insufficient reserves, by exploiting an exogenous regulatory shock.

To determine whether firms' cash holdings are abnormal, it is first necessary to establish a benchmark that represents expected or optimal liquidity levels. This requires estimating what a firm's cash position would be under typical conditions. While, in theory, one could rely on comprehensive models grounded in the fundamental motives for holding cash, such models remain limited. Instead, following standard practice in the literature, I adopt an empirical approach based on Opler et al. (1999). This method estimates normal cash holdings using firm-level characteristics that capture the costs and benefits of liquidity. I extend this approach by regressing cash holdings (cash and cash equivalents scaled by total assets) on these characteristics and then use the fitted values to approximate each firm's optimal or target level of cash. Actual cash balances are then compared with this benchmark, in which positive deviations indicate excess cash, while negative deviations represent insufficient cash, measured in absolute terms. Abnormal cash holdings are thus defined as the absolute deviation, whether excess or insufficient, from the predicted optimal level.

Using a difference-in-differences approach to evaluate the impact of mandatory carbon disclosure on abnormal cash holdings, the analysis indicates that, on average, treatment firms reduced their abnormal cash holdings by 4.66% more than control firms after the regulation, corresponding to about 31.55 million USD. This finding is consistent with agency theory, suggesting improved financial discipline under greater transparency. These effects remain robust after accounting for firm-specific characteristics and additional controls of abnormal cash holdings identified in prior research. Decomposing abnormal cash into excess and insufficient components reveals that excess cash holdings decline significantly at the 1% level after the regulation, whereas insufficient cash holdings increase modestly at the 10% level. Further analysis confirms that the reduction in abnormal cash is driven largely by decreases in excess reserves, with treatment firms reducing excess cash by approximately 20.83% after the regulation. These results remain consistent across alternative model specifications.

I dig deeper into further analysis by examining whether the treatment effect of mandatory carbon disclosure depends on firms' underlying environmental and governance characteristics. While the baseline results show that disclosure regulation reduces abnormal cash holdings on average, it is unlikely that all firms respond uniformly. In practice, heterogeneity in carbon intensity and ownership structure may shape how managers adjust liquidity policies under regulatory pressure. Firms with higher emissions, for example, face stronger stakeholder scrutiny and higher expected compliance costs, which could alter both their precautionary motives and the agency costs of cash. Similarly, firms with greater institutional ownership are subject to tighter monitoring, potentially amplifying the governance benefits of disclosure. Importantly, my earlier analysis in Chapter 3 demonstrates that institutional investors increase their holdings in firms that actively reduce carbon emissions following the regulation. This shift in ownership is concentrated among long-term and sustainability-oriented investors, suggesting that the rise in institutional ownership in treated U.K. firms likely intensifies governance pressure and external monitoring. Exploring these dimensions provides a richer understanding of the channels through which mandatory carbon disclosure affects financial policy.

Accordingly, I conduct a set of cross-sectional analyses focusing on two key moderating factors: firms' GHG emissions and their level of institutional ownership. The results indicate that carbon intensity significantly influences the treatment effect. U.K. firms in high-emission industries experience an additional 7.45% reduction in abnormal cash holdings relative to their low-emission peers, driven primarily by sharp declines in excess cash. However, the effect on insufficient cash holdings is weaker, showing a smaller positive association that is significant only at the 5% level. This suggests that while high-emission firms adjust by reducing excess cash, the evidence of increased liquidity shortfalls is less robust. Overall, these findings highlight that high-emission firms adjust more aggressively to disclosure regulation, reflecting both stronger monitoring pressures and greater compliance-related uncertainty.

Turning to the role of institutional ownership, the evidence shows that investors play a critical moderating role in shaping liquidity policies after the mandate. Firms with higher levels of institutional ownership show greater reductions in abnormal and excess cash holdings compared with control firms, confirming that institutional monitoring helps constrain managerial discretion. At the same time, these firms are more likely to face tighter cash positions, reflected in higher levels of insufficient liquidity. Additional analysis further distinguishes between investor horizons in which firms with stronger long-term institutional ownership reduce abnormal cash significantly after the mandate, while those dominated by short-term investors increase their abnormal cash holdings. Together, these results demonstrate that mandatory carbon disclosure interacts with both environmental exposure and ownership structures to produce heterogeneous financial outcomes. The regulation not only disciplines cash management more strongly in high-emission firms but also amplifies the monitoring role of institutional investors, particularly those with long-term horizons.

This study makes three key contributions to the literature. First, it advances the understanding of exogenous determinants of corporate financial policies, particularly in the area of cash management. While prior research highlights the influence of legal and regulatory environments on firms' cash holding decisions, such as ESG or CSR (Chang et al., 2024; Gao & Gao, 2023; Jadiyappa et al., 2021; Tan et al., 2021). This study provides new evidence that stricter environmental regulations, specifically mandatory carbon disclosure, lead to a reduction in abnormal cash holdings, particularly excess cash.

Second, this study extends the work of Amin et al. (2024), who examined the effect of carbon emissions on abnormal cash holdings in the U.S. using the 2008 Obama election as an exogenous shock. Unlike the largely voluntary U.S. system, the U.K. mandates standardised disclosure, offering a more systematic and enforceable form of environmental reporting. My findings demonstrate that mandatory disclosure produces more consistent reductions in abnormal cash than voluntary regimes, underscoring the importance of regulatory design in influencing corporate financial behaviour.

Third, this study contributes to the growing literature on the financial implications of climate-related risks. The results suggest that firms incorporate regulatory risk into their financing decisions, consistent with the logic of the Myers & Majluf (1984) model, which highlights the preference for internal funds under information asymmetry. By showing that firms adjust liquidity in response to disclosure regulation, this study illustrates how environmental policy can reduce uncertainty, strengthen governance, and encourage the reallocation of resources into productive investment rather than precautionary hoarding. In conclusion, while prior research has focused primarily on the level of cash holdings, my analysis shows that abnormal cash, both excess and insufficient, changes significantly following the introduction of mandatory carbon disclosure. These findings suggest that disclosure influences not only the tendency to hoard resources but also the ability to maintain adequate liquidity. The dual effect highlights the role of disclosure in promoting financial discipline, reducing excess cash, and fostering more efficient allocation of corporate resources. By limiting managers' ability to accumulate idle reserves for non-value-maximising purposes, mandatory disclosure helps align liquidity management with shareholder interests, addressing agency conflicts as emphasised by Jensen (1986). At the same time, the modest increase in insufficient cash suggests that heightened regulatory pressure may also constrain financial flexibility, raising potential risks for firms with limited buffers. Overall, the evidence points to the importance of viewing environmental policy not only as a compliance requirement but also as a governance mechanism that shapes corporate financial decision-making.

The remainder of this chapter is structured as follows. Section 2 reviews the relevant literature and develops the hypotheses. Section 3 introduces the data and summary statistics. Section 4 outlines the research design and the model for estimating normal and abnormal cash levels. Section 5 reports the baseline results, followed by robustness checks in Section 6. Section 7 presents additional analyses, and Section 8 concludes.

5.2 Related literature and hypothesis development

Corporate cash reserve policy reflects a balance between precautionary motives and agency concerns. The precautionary view, emphasised by Keynes (1937) and Miller & Orr (1966), suggests that firms hold cash to fund transactions, finance investments, and protect against adverse cash flow shocks. In contrast, the agency perspective, highlighted by Jensen (1986) argues that managers may retain excess cash for personal benefit or inefficient projects, creating conflicts with shareholders.

Theoretical frameworks formalise these views in different ways. Opler et al. (1999) propose a trade-off model in which firms determine optimal cash levels by weighing the marginal costs and benefits of holding cash. By contrast, the pecking-order theory Myers & Majluf (1984) argues that firms prefer internal financing because information asymmetry makes external financing costly, implying that no unique optimal cash level exists. Empirical studies confirm that firms' cash policies reflect both motives: while reserves provide valuable flexibility (Bates et al., 2009; Kling, 2018), excess holdings can reduce value, particularly when governance is weak (Dittmar & Mahrt-Smith, 2007).

Research on abnormal cash holdings, the deviation of actual from optimal levels, further highlights these tensions. Opler et al. (1999) show that deviations signal future value and performance. Excess cash is often linked to weaker outcomes, especially under poor governance (Dittmar & Mahrt-Smith, 2007; Harford, 1999; Harford et al., 2008). Oler & Picconi (2014) extend this view by showing that both insufficient and excessive cash levels are detrimental. While prior work largely emphasises financial and governance drivers of abnormal cash holdings, much less is known about how external institutional pressures, such as disclosure requirements, affect firms' cash policies.

Mandatory carbon disclosure offers an important setting for examining this link. Unlike traditional financial reporting, carbon disclosure requires firms to provide standardised, transparent information about their environmental impact. Such regulation may influence cash holdings through two competing channels. By reducing information asymmetry, disclosure can strengthen monitoring by investors and limit managerial discretion in hoarding excess cash. At the same time, disclosure introduces compliance costs, reputational risks, and greater regulatory scrutiny, which may heighten uncertainty and encourage firms to retain precautionary cash buffers. These opposing forces suggest that mandatory carbon disclosure could either reduce or increase abnormal cash holdings. In light of these arguments, I propose two competing hypotheses on the effect of mandatory carbon disclosure on abnormal cash holdings.

The Negative Effect of Mandatory Carbon Disclosure on Abnormal Cash Holdings

There may be four reasons why mandatory carbon disclosure may cause firms to reduce their abnormal cash holdings after the regulation. The agency theory of cash holdings argues that excess liquidity provides managers with discretion that may not align with shareholder wealth. Managers can use idle cash to pursue empire building, engage in value-destroying acquisitions, or extract private benefits (Jensen, 1986). Shareholders view such behaviour as an agency cost, since unused cash earns low returns and signals inefficient resource allocation. Empirical studies confirm that firms with weaker governance structures tend to hold more excess cash, which is often dissipated through unproductive investment or operational inefficiencies (Harford, 1999; Dittmar & Mahrt-Smith, 2007). These findings suggest that deviations from optimal cash levels frequently reflect governance problems rather than strategic necessity.

One mechanism to mitigate these agency problems is transparency. When investors and other stakeholders have access to credible information, they can better monitor how managers use corporate resources. Disclosure, therefore, plays a central role in aligning managerial and shareholder interests. Harford et al. (2008) show that firms with stronger governance are less likely to waste excess cash on inefficient acquisitions, while Dittmar & Mahrt-Smith (2007) find that shareholder oversight improves the value consequences of cash holdings. By mandating standardised, verifiable reporting of environmental performance, carbon disclosure enhances the overall information environment[18], making it more difficult for managers to justify holding excessive liquidity.

A second mechanism arises from the role of institutional investors. Prior work shows that institutional ownership functions as an external governance mechanism that disciplines managerial behaviour and constrains excess cash (Ferreira & Vilela, 2004; Harford et al., 2008). Mandatory carbon disclosure provides investors with comparable and credible environmental data, strengthening their ability to detect mismanagement and intervene when necessary. Dyck et al. (2019) demonstrate that greater transparency empowers investors to influence corporate policies, including liquidity management. In this way, disclosure amplifies the monitoring capacity of institutional investors, increasing reputational and activist pressures on managers to reduce abnormal cash holdings.

[18] As mentioned in the Chapter 2, The 2013 U.K. mandatory carbon disclosure regulation required firms to report their greenhouse gas (GHG) emissions within the annual financial report, ensuring that the information was presented alongside financial data and thereby making it easier for investors and stakeholders to access and evaluate.

A third mechanism concerns financing constraints. Firms often justify precautionary cash buffers as insurance against external financing frictions. However, evidence suggests that credible environmental disclosure can improve a firm's financing environment. For example, Dhaliwal et al. (2012) and El Ghoul et al. (2011) find that sustainability disclosure is associated with lower cost of capital and improved credit ratings. Clarkson et al. (2020) similarly, show that carbon disclosure enhances the information environment, easing access to external finance. When investors trust a firm's disclosures, capital markets become more willing to supply funds on favourable terms. As a result, firms will have less of a need to hold abnormal levels of cash as a precautionary buffer.

Finally, mandatory disclosure can generate efficiency and competitiveness gains consistent with the Porter Hypothesis (Porter & van der Linde, 1995). By requiring transparency on environmental practices, disclosure pressures firms to improve resource efficiency, adopt cleaner technologies, and integrate sustainability into strategy. Such improvements not only reduce compliance costs but also enhance reputation, product quality, and operational performance (Ambec et al., 2010). As efficiency gains materialise, managers face reduced incentives to hoard cash for agency purposes, while improved competitiveness lowers the precautionary demand for liquidity.

Overall, these mechanisms suggest that mandatory carbon disclosure reduces abnormal cash holdings by limiting managerial discretion, empowering investors, improving financing access, and enhancing operational efficiency. By strengthening oversight and aligning corporate practices with stakeholder expectations, disclosure discourages the accumulation of idle reserves and promotes more efficient use of resources. Drawing on this discussion, I formulate the hypothesis as follows:

H1a: Mandatory carbon disclosure is negatively associated with abnormal cash holdings.

The Positive Effect of Mandatory Carbon Disclosure on Abnormal Cash Holdings

A large body of research suggests that firms retain cash as insurance against uncertainty, consistent with the precautionary theory of cash holdings first articulated by Keynes (1937) and later formalised in models of liquidity management (Miller & Orr, 1966; Opler et al., 1999). Cash enables firms to absorb adverse shocks, smooth operations, and avoid reliance on costly external financing. Empirical studies confirm that firms facing greater cash flow volatility, tighter financial constraints, or heightened exposure to risk tend to build larger liquidity buffers (Almeida et al., 2004; Bates et al., 2009; Dittmar & Duchin, 2010). In this sense, maintaining excess liquidity is a rational response to environmental and financial uncertainty, even if it results in cash holdings above model-predicted optimal levels.

Mandatory carbon disclosure has the potential to intensify such precautionary motives by amplifying both regulatory and market uncertainty. By compelling firms to report their carbon emissions in a standardised and comparable manner, disclosure exposes them to new risks, including increased regulatory oversight, reputational damage, and potential litigation, particularly for carbon-intensive firms. Firms with high emissions may reasonably anticipate stricter environmental policies in the future, leading managers to accumulate precautionary reserves as a buffer against future compliance costs and strategic constraints. Even for lower-emission firms, the act of disclosure may reveal risks that investors and regulators had not previously priced in, raising perceptions of exposure and reinforcing incentives to hoard cash.

In addition to uncertainty, disclosure entails direct compliance costs. Preparing, auditing, and publishing carbon data requires financial and managerial resources, and in many cases, firms must upgrade internal monitoring systems or redesign production processes to ensure accurate reporting. Prior studies document that compliance with environmental regulation often generates significant transitional costs, including capital upgrades, site remediation, or adjustments in supply chain management (Gray & Shadbegian, 1997;

Schneider, 2011). These expenditures are rarely one-off; disclosure implies recurring obligations to monitor and report emissions, further increasing the value of liquidity as a safeguard against recurring costs. Managers may therefore deliberately hold cash balances above target levels to prevent liquidity shortfalls when such obligations materialise.

Mandatory disclosure may also exacerbate financing frictions, reinforcing the value of internal cash as a substitute for constrained external capital. Green innovation and environmental adaptation projects are typically long-term, information-sensitive, and costly to finance externally. Creditors and investors may demand higher risk premiums or undervalue securities for firms perceived as environmentally unfriendly, raising borrowing costs and restricting credit access (Fard et al., 2020; Myers & Majluf, 1984). As a result, managers may anticipate difficulties in raising funds when needed and therefore accumulate abnormal cash reserves as a form of self-insurance. In this sense, deviations from optimal cash holdings reflect rational precautionary planning rather than managerial inefficiency.

Finally, disclosure can encourage firms to retain cash to finance strategic innovation and adaptation. Investments in green R&D, clean technologies, and sustainable business practices are resource-intensive, irreversible, and difficult to adjust once undertaken. Prior research shows that firms require stable internal funding to sustain R&D, particularly during periods of regulatory or market volatility (Denis & Sibilkov, 2010; Zhang & Zhou, 2022). Cash, therefore, plays a stabilising role, enabling firms to maintain innovation programs without disruption. From this perspective, mandatory disclosure promotes not only short-term precautionary buffers but also longer-term liquidity retention for strategic transformation.

Collectively, these mechanisms suggest that mandatory disclosure increases abnormal cash holdings by amplifying uncertainty, increasing compliance costs, raising financing frictions, and reinforcing the strategic importance of liquidity for adaptation. This leads to my second hypothesis;

H2a. Mandatory carbon disclosure is positively associated with abnormal cash holdings.

In the empirical analysis, I test these hypotheses and further distinguish between excess and insufficient cash holdings to explore potential differences. The following section describes the data sample and reports the summary statistics.

5.3 Data and summary statistics

5.3.1 Main independent variables

To examine the impact of the legislation on cash holdings management, I construct a panel of U.K. and European firms over the period 2008–2018. The sample begins in 2008, five years prior to the introduction of mandatory carbon reporting in the U.K., allowing sufficient pre-regulation observations. I end the sample in 2018 to avoid potential distortions arising from the COVID-19 pandemic. I extend the sample period beyond the first two chapters because cash holdings adjust gradually toward target levels rather than immediately. This gradual adjustment reflects the presence of adjustment costs and liquidity management frictions documented in prior research.

To identify U.K. firms directly affected by the regulation, I restrict the treatment group to firms incorporated in the U.K. and listed on the Main Market of the London Stock Exchange (LSE), consistent with the scope of the policy. Because large U.K. firms rarely choose another primary listing venue, focusing on the LSE captures the vast majority of relevant firms and follows prior research practice (e.g., Jouvenot & Krueger, 2019). I obtain the list of qualifying firms directly from the LSE website and use it to construct the treatment sample. I then match these firms with financial and emissions data from S&P Capital IQ using company names. This procedure results in a final treatment sample of 167 U.K. firms, which is consistent with earlier studies examining the same regulation (e.g., Downar et al., 2021; Jouvenot & Krueger, 2019).

For the control group, I construct a panel of firms incorporated and listed on major European stock exchanges outside the U.K. This approach allows me to compare U.K. firms subject to mandatory carbon reporting with similar European firms operating under comparable market conditions but not exposed to the same disclosure requirement. I apply the same data collection and matching procedure using S&P Capital IQ, which yields a control sample of 1,168 European firms. I then apply several filters to ensure comparability and data quality. I exclude financial firms (SIC codes 6000–6999) because their regulatory environment and balance sheet structure differ substantially from non-financial firms. I also exclude firms with total assets below USD 100 million to remove very small firms whose cash policies may reflect liquidity constraints rather than strategic liquidity management. In addition, I exclude firms with missing information required to estimate optimal cash holdings, as these observations prevent the construction of abnormal cash measures. The detailed procedure for computing abnormal, excess, and insufficient cash holdings is provided in Section 5.3.2.

[Table 5-1 about here]

After applying these filters, I obtain a final unbalanced panel consisting of 1,335 firms and 14,685 firm-year observations across European countries. Table 5-1 reports the detailed sample construction procedure, including the number of firms and firm-year observations at each stage of the filtering process.

My primary variable of interest is the interaction between the treatment and post-regulation indicators, which captures the effect of mandatory carbon disclosure on abnormal cash holdings, a method referred to as the Difference-in-Differences (DiD) approach, ($Treated_i$

× $After_t$). $Treated_i$ identifies the treatment group, defined as firms incorporated in the U.K. and listed on the Main Market of the London Stock Exchange that became subject to the disclosure Act 2013, which took effect on September 30, 2013. Firms not required to comply with the regulation, other listed European firms, serve as the control group. The second indicator, $After_t$, is a staggered post-treatment dummy (as explained earlier) that equals one for firms with fiscal years ending on or after September 30, and 2014 for those with earlier fiscal year ends, consistent with Jouvenot and Krueger (2019).

For the additional analyses, I incorporate carbon emissions levels and the actual levels of institutional ownership to assess whether these variables influence the impact of mandatory carbon disclosure on firm-level cash holdings. This is examined using a double difference-in-differences (DiDiD) approach. I obtain all firm-level carbon emissions data to generate high and low-carbon emissions firms from Trucost in thousands of metric tons of carbon dioxide equivalent (thousand MtCO2e). To examine heterogeneity in firms' responses to mandatory carbon disclosure, I classify firms into high- and low-emission groups while also retaining their continuous emission levels for additional analysis. Following the approach of Jouvenot and Krueger (2019), I define high-emission firms as those whose annual GHG emissions intensity exceed the sample median in a given year. This median split ensures that the classification is dynamic, accounting for yearly variation in emissions intensity across firms, rather than being fixed at a single threshold.[19]

For institutional ownership data, I collect fiscal year-end individual-level institutional ownership from Capital IQ. I construct an aggregate firm-level measure of institutional

[19] The use of the median as a cut-off is consistent with prior studies in climate finance, which emphasise relative differences in carbon intensity as a key determinant of regulatory exposure and stakeholder scrutiny (e.g., Bolton & Kacperczyk, 2021; Ilhan et al., 2021). Firms above the median face higher reputational risks, greater potential compliance costs, and stronger monitoring pressures, making them particularly relevant for testing how disclosure regulation interacts with environmental risk.

ownership, defined as follows:

$$IO_{it} = \sum_{j=1}^{n} IO_{\text{jit}} \quad (5\text{-}1)$$

where IO_{jit} denotes the equity ownership (measured as the percentage of total outstanding shares) held by institutional investor j in firm i at the end of fiscal year t. The firm-level aggregate institutional ownership, IO_{it}, is obtained by summing all individual institutional holdings (IO_{jit}) for firm *i* in year *t*. This aggregate measure, expressed as a percentage of the firm's total shares outstanding, captures the overall extent of institutional investor participation in each firm. Consistent with prior research (e.g., Dyck et al. (2019) and Marshall et al. (2022)), this firm-level measure is employed in the additional analysis to implement DiDiD approach, allowing for the assessment of institutional ownership dynamics in response to the regulatory event.

5.3.2 Dependent variable: Abnormal cash holdings, Excess and Insufficient Cash Holdings

This study aims to examine whether mandatory carbon disclosure affects firms' abnormal cash holdings. The primary dependent variable in this study is abnormal cash holdings, which encompass both excess and insufficient cash levels. Consistent with the approach of Oler & Picconi (2014), abnormal cash holdings are calculated by subtracting a firm's actual reported cash holdings and its estimated target level.

The study of Opler et al. (1999) suggests that firms manage a trade-off between two competing costs: the risk of foregoing valuable investment opportunities due to limited access to capital markets and the cost of holding liquid assets such as cash, which carry a liquidity premium. This balance indicates that firms manage their cash holdings to achieve an optimal level consistent with their operational, investment, and financing requirements. However, the concept of a fixed optimal cash level becomes questionable when considering that a firm's cash needs can fluctuate over time in response to external conditions. For instance, a financial crisis would likely shift a firm's ideal cash balance compared to a more stable economic environment. Nonetheless, many empirical studies cited in this section continue to treat optimal cash levels as static over time. In this study, I assume that the optimal cash holdings remain constant over time before the introduction of mandatory carbon disclosure.

5.3.2a Computing optimal cash holdings

To obtain estimates of *optimal or normal cash holdings*[20], following and applying the methodology of Oler & Picconi (2014) and Bates et al. (2009), I first estimate a firm's optimal level of cash to measure abnormal cash holdings. Oler and Picconi (2014) modify the model of Opler et al. (1999) and develop the following Equation (5-2) for the target (optimal) cash estimation. This approach models corporate cash holdings as a function of firm-level determinants associated with the precautionary, transaction, and agency motives for holding cash. In this study, I define cash holdings as cash and cash equivalents scaled by total assets. I estimate the target (optimal) level of cash using a five-year regression window that ends prior to the introduction of the regulation. Specifically, I estimate Equation (5-2) over the period 2007–2011, which covers the five years preceding the 2013 regulatory shock. Estimating the model using only pre-regulation data ensures that the coefficients are not influenced by changes in cash policies after the regulation.

I use firm-specific effects that are significantly influencing the firm's cash management behaviour, including cash flow, capital expenditure, leverage, R&D expenditure, net working capital, merger & acquisitions, dividend payment, and firm age, following previous studies

[20] Some paper call 'the target cash holdings' such as Choi et al. (2018)

(see, for example, Choi et al., 2018; Oler & Picconi, 2014).[21]

The model for estimating optimal cash holdings is specified as follows:

$$Opcash_{it}=\alpha+ \beta_1.CF_{it} + \beta_2.NWC_{it} + \beta_3.Capex_{it} + \beta_4.Lev_{it} + \beta_5.RD_{it} + \beta_6.Div_{it} + \beta_7.MA_{it} +\beta_8.Age_{it}+\gamma_t+\tau_j+\lambda_s+\varepsilon_{it} \quad (5\text{-}2)$$

where $Opcash_{it}$ denotes the dependent variable, measured as the ratio of cash and cash equivalents to total assets for firm *i* in year *t*. The explanatory variables include several firm-level determinants of cash holdings: operating income before interest and taxes to total assets (CF), net working capital to total assets (NWC), research and development expenditures to total assets (RD), capital expenditures to total assets ($Capex$), total debt to total assets (Lev), total dividends paid to total assets (Div), mergers and acquisitions to total assets (MA), and the natural logarithm of firm age (Age). Because both the dependent variable and key explanatory variables are scaled by total assets, the total assets control variable is excluded from the regression specification, following the approach of Jouvenot and Krueger (2019). To mitigate the influence of extreme observations and data errors, all continuous variables are winsorized at the 1st and 99th percentiles, consistent with Oler and Picconi (2014). The model further includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects to control for unobserved time-, sector-, and market-specific heterogeneity.

For each firm and year, I calculate the target (or optimal) cash level by applying the estimated coefficients of model (5-2) to the firm's financial variables for that year; the fitted value serves as the proxy for the firm's optimal cash holdings (Choi et al., 2018; Fresard, 2010). These predicted targets are used throughout the paper to measure firms' optimal cash levels.

[Table 5-2 about here]

[21] Variable descriptions are in appendix 5-A1

Table 5-2 presents the estimation results of model (5-2). The estimated coefficients are broadly consistent with the established corporate finance literature on the determinants of corporate cash holdings (e.g. Almeida et al., 2004; Bates et al., 2009; Opler et al., 1999). Operating cash flow is positively and significantly associated with cash holdings, consistent with the precautionary motive for liquidity management. Firms with stronger internal cash generation accumulate larger cash buffers to hedge against future financing frictions and adverse shocks. Net working capital exhibits a positive and significant association with cash holdings, suggesting complementary liquidity management rather than strict substitution between liquidity components. While prior literature often documents substitution effects between cash and non-cash working capital (Opler et al., 1999), more recent evidence indicates that firms may simultaneously manage multiple liquidity channels depending on uncertainty and financing constraints. Capital expenditures are negatively related to cash holdings, indicating that firms with higher investment demand maintain lower cash reserves, consistent with the use of internal liquidity to finance capital investment (Harford, 1999; Opler et al., 1999). R&D intensity is strongly positively associated with cash, consistent with growth firms maintaining higher liquidity buffers to finance uncertain and intangible investment opportunities. Firms with greater innovation intensity face higher cash flow volatility and limited collateral capacity, which increases precautionary cash demand (Bates et al., 2009). Firm age is negatively related to cash holdings, reflecting that mature firms typically experience lower uncertainty and improved access to external capital markets. Younger firms, by contrast, are more financially constrained and therefore retain larger liquidity buffers (Bates et al., 2009; Faulkender & Wang, 2006).

5.3.2b Computing Abnormal, Excess, and Insufficient cash holdings

To construct a firm-year measure of abnormal cash holdings, I subtract the estimated optimal (target) cash level from the firm's actual reported cash holdings. I compute abnormal cash as the difference between actual cash and predicted cash obtained from Equation (5-3). Formally, I calculate predicted (optimal) cash as:

$$\widehat{Cash}_{it}$$

I then define abnormal cash holdings as:

$$AbCash_{it} = Cash_{it} - \widehat{Cash}_{it} \tag{5-3}$$

A positive value indicates that the firm holds more cash than predicted by its economic fundamentals, which I interpret as *excess cash*. A negative value indicates that the firm holds less cash than predicted, which I interpret as *insufficient cash*. This measure captures the portion of cash holdings that cannot be explained by economic determinants such as profitability, leverage, investment, and growth opportunities, and therefore reflects discretionary liquidity management.

To provide further insight, I decompose abnormal cash into two components: excess cash and insufficient cash. I define *excess cash holdings* as the positive difference between actual and optimal cash, and zero otherwise. This measure captures the extent to which a firm holds cash above its optimal level.

I define *insufficient cash holdings* as the absolute value of the shortfall when actual cash is below the predicted level, and zero otherwise. This measure captures the extent to which a firm is underfunded relative to its optimal cash level. In constructing these measures, I follow the approach commonly used in the corporate finance literature (Choi et al., 2018; Dittmar & Mahrt-Smith, 2007a; Oler & Picconi, 2014; Opler et al., 1999). I use these measures of abnormal, excess, and insufficient cash as dependent variables in the Difference-in-Differences analysis to test whether the 2013 regulatory shock influences firms' discretionary cash policies.

5.3.3 Control variables

The control variables represent empirically validated determinants of firm cash holdings, and I measure all of them with a one-year lag to mitigate concerns of reverse causality. Following prior literature, I include cash flow/total assets (CF), net working capital/total assets (NWC), sales growth, capital expenditure/total assets (Capex), total debt/total assets (Lev), Age of firm (Age), and mergers and acquisitions (MA). Variable definitions are documented in detail in the Appendix (Table 5-A1). Since firms' cash holdings are normalised by total assets, I drop the total asset control variable from the specification in the spirit of Jouvenot & Krueger (2019).

5.3.4 Summary statistics

Table 5-3 panel A presents the summary statistics for the variables used in the empirical analysis. The average (median) cash ratio is 0.1142 (0.0848), indicating that, on average, firms in the sample retain cash equivalent to approximately 11.42% of their total assets, equivalent to roughly 747.15 million USD. The mean abnormal cash holding is 0.0655, representing approximately 57.36% of the average cash holding (0.0655/0.1142), which corresponds to an average value of approximately 304.50 million USD. The logarithm of total carbon emissions has a mean (median) value of 6.3532 (6.2185) and a standard deviation of 1.8797, reflecting substantial cross-country variation in environmental regulatory frameworks, consistent with findings by Amin et al. (2024).

[Table 5-3 about here]

On average, firms in the sample have total assets valued at approximately 6,542.46 million USD, indicating their relatively large size. Additionally, the sample firms exhibit modest sales growth, averaging 7.37%, a characteristic typical of mature and established firms. The data also indicate that firms tend to retain a greater proportion of cash from debt issuance as opposed to equity issuance, a pattern commonly observed among large and financially stable firms. Furthermore, the sample firms demonstrate moderate leverage levels and relatively low sales growth, consistent with the profile of established firms operating in developed markets. Descriptive statistics for other explanatory variables are comparable to those reported in prior literature (e.g., Francis et al., 2004, 2008; Chen et al., 2011).

Panel B of Table 5-3 presents the Pearson correlation matrix for the variables used in the main analysis. The results indicate that multicollinearity among the main independent variables (variables 2 – 9) is not apparent, as the highest correlation coefficient, observed between leverage and net working capital ($r = 0.498$), is only moderate. Furthermore, in the untabulated results, the variance inflation factor (VIF) results do not indicate multicollinearity issues, as all VIF values are below 5.

The correlation results indicate a significant negative association between total carbon intensity and abnormal cash holdings. However, the interpretations of the correlation table remain preliminary as they do not control for other determinants to fully understand the relationship between carbon emissions intensity and abnormal cash holdings. I explore it further using detailed multivariate regression analysis. Additionally, the correlations suggest that older firms, as well as those with higher capital expenditure, leverage, and merger and acquisition activities, tend to hold less cash. Conversely, firms characterised by higher cash flow, greater net working capital, higher research and development expenditures, and stronger sales growth tend to retain more cash.

Figures 5-1 and 5-2 provide graphical evidence of the dynamic responses of abnormal cash holdings and excess cash around the introduction of the U.K. mandatory carbon disclosure regulation in 2013. These figures complement the regression-based difference-in-differences results by illustrating both the direction and the speed of adjustment for treated (U.K.) and control (EU) firms over time.

Figure 5-1 panel A and B plots the annual mean and median abnormal cash holdings for U.K. and EU firms from 2008 to 2018. Prior to 2013, both groups exhibit relatively parallel trends in abnormal cash levels, supporting the identifying assumption of comparable pre-regulation trajectories. However, following the implementation of the mandatory disclosure requirement, a noticeable divergence emerges. U.K. firms display a clear and persistent decline in abnormal cash holdings relative to EU firms (both in Panel A and B).

[Figure 5-1 about here]

The timing of the adjustment is economically meaningful. The reduction in abnormal cash holdings becomes visible immediately after 2013 and continues gradually over the subsequent years, rather than occurring as a one-off discrete drop. This pattern suggests that firms adjust their cash policies progressively as enhanced transparency increases investor monitoring and stakeholder scrutiny. The gradual decline is consistent with governance-driven adjustment rather than short-term liquidity shocks.

Figure 5-2 reports the annual mean (Panel A) and median (Panel B) of excess cash holdings for my sample firms over the period 2008–2018. I define excess cash as the positive deviation between actual cash ratios and predicted (optimal) cash levels estimated from the baseline cash regression presented in Table 5-2. In Panels A and B, I observe that prior to the introduction of the U.K. mandatory carbon disclosure regulation in 2013, excess cash holdings for U.K. and EU firms follow broadly similar trajectories. The mean and median series move in parallel during the pre-treatment period, supporting the identifying assumption that treated and control firms exhibit comparable liquidity behaviour before the regulatory shock.

[Figure 5-2 about here]

Following the implementation of mandatory carbon disclosure in 2013, I observe a noticeable decline in excess cash holdings among U.K. firms relative to EU firms. This divergence appears in both the mean and median measures, indicating that the adjustment is not driven solely by extreme observations but reflects a broad-based shift in corporate liquidity management. The reduction is more pronounced in the mean than in the median. I interpret this pattern as evidence that firms with initially high levels of excess liquidity reduce their cash buffers more aggressively after the regulatory shock. This finding is consistent with agency theory, which predicts that excess cash, often associated with managerial discretion over free cash flow, should decline when monitoring intensity increases (Jensen).

I further observe that the adjustment in excess cash is gradual rather than instantaneous. Although I detect a downward shift beginning in 2013, the decline continues over the subsequent two to three years before stabilising at a lower level. I interpret this gradual adjustment as consistent with dynamic cash policy models, where firms move toward target cash ratios over time due to adjustment costs and financial frictions (Bates et al., 2009). This dynamic pattern also suggests that the observed decline reflects structural governance improvements rather than short-term liquidity shocks. If the effect were driven purely by temporary macroeconomic conditions, I would expect to observe a sharp and transitory drop. Instead, the sustained reduction indicates a persistent change in liquidity discipline following enhanced environmental transparency.

5.4 Research design

To address potential concerns regarding omitted variable bias, this study employs a Difference-in-Differences (DID) methodology. Specifically, the DID framework facilitates the identification of the causal impact of mandatory carbon disclosure regulations on abnormal cash holdings by comparing changes observed in firms significantly affected by these regulatory changes with those in unaffected firms. In practical terms, this research approximates a quasi-natural experimental design by defining publicly listed firms in the U.K. as the treatment group, while selecting comparable publicly listed firms from other European countries as the control group. Under the null hypothesis of no regulatory effect, this relative change (the DiD estimate) should be statistically indistinguishable from zero. A negative estimate would mean that, after the disclosure requirement, U.K. firms reduced abnormal cash holdings more than European firms; a positive estimate would mean they increased abnormal cash holdings more than European firms. Thus, the sign and significance of the DiD coefficient indicate whether and in which direction the regulation affected firms' cash policies.

To examine this hypothesis, I estimate the following regression equation for firm i, in industry j, listed on stock exchange s, in year t:

$$ABCASH_{it} = \alpha + \beta_1.(Treated_i \times After_t) + \beta_2.Treated_i + \beta_3.After_t + \beta_4 X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it} \quad (5\text{-}4)$$

In this specification, the dependent variable, *ABCASH*, represents a firm's *abnormal cash holdings*, calculated as the deviation from predicted normal cash levels. The key variable of interest is the interaction term *(Treated × After)*, which captures the causal effect of the mandatory greenhouse gas (GHG) disclosure regulation on firms' abnormal cash holdings. The variable *Treated* is an indicator variable equal to one if a firm is a U.K. company listed on the Main Market of the London Stock Exchange, and zero otherwise. The regulation applies to all fiscal years ending on or after September 30, 2013**.** Therefore, for firms whose fiscal year ends on or after this date, *After* equals one from 2013 onward, whereas for firms with earlier fiscal year ends, it equals one beginning in 2014. This staggered timing ensures that treatment occurs consistently with the effective compliance dates of the regulation. The vector X_{it-1} includes lagged firm-level control variables that account for determinants of cash holdings such as profitability, leverage, investment opportunities, firm size, and cash flow volatility. Standard errors are clustered at the stock exchange level to correct for serial correlation and heteroskedasticity. This specification allows the coefficient β_1 to be interpreted as the average treatment effect of the mandatory GHG disclosure requirement on abnormal cash holdings, under the parallel-trend assumption central to the DiD framework.

The multivariate analyses incorporate a comprehensive set of control variables to mitigate potential confounding factors that could jointly influence firms' mandatory carbon disclosure and cash-holding behaviour. Specifically, the model includes *industry fixed effects* to absorb unobservable, time-invariant heterogeneity across sectors. For example, energy-intensive industries such as utilities, mining, and manufacturing typically face higher compliance costs and environmental scrutiny, which may shape both their disclosure decisions and their preference for maintaining precautionary cash reserves. Given that industry affiliation significantly influences both climate risk exposure (e.g., through emissions and reputational costs) and cash holdings behaviour (e.g., via enhanced access to financial resources and strategic advantages), following prior literature (e.g. Bilyay-Erdogan et al., 2023; Fresard, 2010; Jouvenot & Krueger, 2019), all regressions use industry fixed effects (defined at the four-digit SIC level). *Year dummies fixed effects* are included to address time trend effects, such as the increase in cash reserve behaviour regarding economic uncertainty. *Stock exchange fixed effects* address country-specific, time-invariant differences such as economic development, cultural norms, or policy. They control for time-varying, unobserved factors that could bias the results, improve the model's validity, and ensure that policy evaluation is accurate. Without fixed effects, the results might be confounded by external shocks, time trends, or macroeconomic conditions unrelated to the policy of interest.

The results of this chapter should also be interpreted within the broader regulatory context in which the disclosure reform was implemented. As discussed in Section 2.6 of Chapter 2, the introduction of mandatory carbon disclosure in 2013 coincided with the implementation of the U.K. Carbon Price Floor, which increased the effective carbon price faced by U.K. firms relative to many European counterparts. While carbon pricing primarily operates through cost and investment channels, the focus of this chapter is on corporate liquidity management and abnormal cash holdings as responses to enhanced transparency and investor monitoring. The empirical design therefore isolates the differential effects associated with mandatory disclosure rather than the direct cost implications of carbon pricing, although both policies form part of the wider climate policy framework during the sample period.

5.4.1 Parallel trend assumption

A key identifying assumption of the Difference-in-Differences (DiD) framework is that treated and control firms would have followed parallel trends in the absence of the regulation. A potential concern is that U.K. firms may have differed systematically from European firms prior to the introduction of mandatory carbon disclosure, and that such pre-existing differences could drive the observed results. For example, prior research shows that firm characteristics such as size, financial constraints, and growth opportunities influence cash-holding behaviour (Bates et al., 2009; Opler et al., 1999). If these characteristics evolved differently across U.K. and European firms before 2013, the estimated treatment effects could reflect underlying heterogeneity rather than the regulatory shock.

To assess this concern, I estimate an event-study specification based on Equation (5-3), replacing the post-regulation indicator with a full set of year-specific interaction terms between the treatment indicator and annual dummies for the period 2008–2018. I use 2012 as the omitted base year, as it is the final year prior to the introduction of the 2013 regulation. All coefficients are therefore interpreted relative to this pre-policy benchmark. Because 2012 is normalised to zero, it does not appear in the figure.

[Figure 5-3 about here]

Figure 5-3 presents the estimated interaction coefficients and their 95% confidence intervals. The plotted coefficients represent the yearly differences in abnormal cash holdings between U.K. (treatment) and European (control) firms relative to 2012. The shaded areas correspond to the 95% confidence intervals. The pre-treatment coefficients (2008–2011) are generally small in magnitude and statistically insignificant, indicating no systematic divergence in abnormal cash holdings prior to the regulation. Although the coefficient for 2008 is statistically significant at conventional levels, its magnitude is economically small and does not reflect a persistent or systematic pre-trend. Importantly, the remaining pre-treatment coefficients are statistically indistinguishable from zero, and there is no observable upward or downward pattern in the pre-regulation period. The absence of a consistent pre-trend supports the validity of the parallel trends assumption. The detailed regression estimates that generate Figure 5-3 are provided in Appendix Table 5-A2.

I interpret the isolated significance in 2008 as statistical noise rather than evidence of a violation of the parallel trends assumption. As emphasized by Angrist & Pischke (2009), the presence of a single significant pre-treatment coefficient does not necessarily invalidate a DiD design, particularly when it is not accompanied by a systematic pre-trend. Bertrand et al. (2004) similarly caution that sampling variation may produce occasional significant estimates even when the identifying assumption holds. More recent work by Roth (2022) further clarifies that researchers should focus on whether pre-treatment coefficients display systematic patterns rather than on isolated statistical significance. Because I do not observe consistent pre-treatment divergence, and because the post-treatment coefficients shift only after 2013, I conclude that the identifying parallel trends assumption is satisfied. Therefore, the DiD estimates can be interpreted as capturing the causal impact of the regulation on firms' discretionary cash holdings. Overall, Figure 5-3 provides evidence that, absent the regulation, abnormal cash holdings in U.K. and European firms would have evolved similarly. This finding supports the identification strategy and satisfies the key assumption underlying the DiD framework (Angrist & Pischke, 2009; Bertrand et al., 2004).

In this study, I do not employ propensity score matching (PSM) prior to implementing the DiD framework. The credibility of DiD identification rests on the parallel trends assumption, which I explicitly test and validate using the event-study specification. Moreover, the number of firm-level carbon emissions observations in the dataset is relatively limited, and applying PSM would further reduce the sample size, thereby lowering statistical power and increasing inefficiency (Heckman et al., 1997). Recent methodological critiques also highlight that PSM can increase imbalance, inefficiency, and bias when used improperly, a phenomenon known as the "PSM paradox" (King & Nielsen, 2019). Given these concerns, I rely on testing and confirming pre-treatment parallel trends rather than matching firms prior to estimation.

5.5 Baseline results

5.5.1 Does mandatory carbon disclosure affect firm-level abnormal cash holdings?

As shown in Table 5-4, the empirical results provide evidence for Hypotheses 1a and 1b. The key coefficient of interest, the interaction term DiD (Treated × After), is consistently negative and statistically significant across two model specifications, indicating strong support for the proposed hypotheses. A baseline model without controls (Column 1), the coefficient is -0.0024, while the full model with control variables (Column 2) yields a coefficient of -0.003. This indicates that mandatory carbon disclosure regulation, on average, leads to a significant decline in abnormal cash holdings in U.K. firms following the disclosure mandate compared to European firms. Specifically, treated firms reduce their abnormal cash by approximately 4.66% (0.003/0.0644 = 4.66%, 0.0644 is the average abnormal cash holdings of U.K. firms) after the regulation compared to control firms. In monetary terms, given that the average total assets of treated firms are approximately 10,515 million USD, this corresponds to an average decrease of about 31.55 (0.003*10,515=31.55) million USD in abnormal cash holdings per firm per year.

The findings align with prior literature (Alexander et al., 2024; Deng et al., 2023; H. Gao et al., 2013; Tan et al., 2021; Zadeh et al., 2023), which suggests that greater CSR and environmental transparency are associated with lower corporate cash holdings. Zadeh et al. (2023a), for example, emphasise that enhanced CSR disclosure reduces information asymmetry and agency problems, prompting firms to hold less precautionary cash, and the negative effect of mandatory carbon disclosure is especially pronounced in firms characterised by high information asymmetry, weak governance, or low financial reporting quality. My study's findings are also consistent with earlier research showing that environmental regulation can alter firms' cash holding strategies (e.g. Xue, 2023). Similar to Amin et al. (2024), who use the 2008 U.S. presidential election as an exogenous shock, this study supports the precautionary motive by showing that increased regulatory transparency reduces firms' incentives to hoard cash. The evidence suggests that disclosure mandates improve cash management efficiency and reduce the need for excessive cash reserves. My results support the hypothesis that environmental disclosure mandates influence corporate financial behaviour by enhancing transparency and accountability.

[Table 5-4 about here]

Regarding control variables, Cash flow (CF) has a significantly positive association with abnormal cash holdings, consistent with the notion that riskier cash flows hold relatively high cash holdings (Gao & Gao, 2023; Opler et al., 1999). Leverage (Lev) also exhibits a positive coefficient and is consistent with the literature (Bates et al., 2009; Tan et al., 2021; Zhang et al., 2024). Generally, leverage influences cash holdings through its impact on financial risk and liquidity needs. Firms may increase cash holdings to mitigate the risks of financial distress and bankruptcy (Denis & Sibilkov, 2010). The study of Choi et al. (2018) indicates that abnormal cash holdings, whether excessive or insufficient, are linked to higher costs of equity capital. This suggests that investors perceive abnormal cash levels as signals of risk, which can affect the firm's financial strategy and leverage decisions. Capital expenditure (Capex) is negatively related to abnormal cash holdings, reinforcing the idea that firms investing more in fixed assets retain less liquid cash (Gao & Gao, 2023; Xue, 2023). Net working capital (NWC), on the other hand, has a positive effect, suggesting that firms with more working capital maintain higher cash buffers for operational flexibility (Oler & Picconi, 2014). Mergers & Acquisitions (M&A) have a significant negative impact on abnormal cash holdings. Firms may engage in acquisitions to achieve long-term growth and diversification, which can ultimately enhance shareholder value despite short-term negative effects on cash holdings. According to Erel et al. (2021), when economic conditions are favourable, firms face less need to maintain large cash reserves and are therefore more inclined to use their resources to pursue acquisitions. This results in a decline in cash holdings as firms utilise their reserves for M&A activities.

These findings support Hypothesis 1a, affirming a negative association between mandatory carbon disclosure and abnormal cash holdings. From an agency theory perspective, the results imply that improved transparency and reduced information asymmetry mitigate managerial incentives to accumulate excess cash. Furthermore, the results complement the

Porter Hypothesis, which posits that well-designed environmental regulations can encourage innovation, improve operational efficiency, and ultimately enhance firm competitiveness, which can imply that mandatory carbon disclosure regulations push firms to adopt more efficient and sustainable practices. These changes can lead to better resource allocation and reduced inefficiencies, thereby lowering the need for firms to hold abnormal levels of cash as a buffer against regulatory uncertainty or operational inefficiencies. Consistently, this study supports the view that CSR transparency improves firms' financial decision-making by enhancing the market value relevance of cash and easing financing constraints (Zadeh et al., 2023).

These results can be interpreted through the broader theoretical lenses of agency theory, signalling theory, and stakeholder theory. From an agency perspective, the reduction in abnormal cash holdings following mandatory disclosure is consistent with the idea that transparency and stronger monitoring reduce managers' ability to accumulate free cash flows for private benefit (Dittmar & Mahrt-Smith, 2007; Jensen, 1986). By curbing agency-driven hoarding, disclosure regulation aligns cash policies more closely with shareholder interests. From a signalling perspective, reducing excess cash and distributing resources more efficiently can serve as a credible signal of financial discipline and long-term value creation, reassuring investors of the firm's resilience under heightened regulatory scrutiny. Finally, stakeholder theory suggests that carbon disclosure responds not only to shareholder oversight but also to broader societal and environmental expectations. Firms that reduce abnormal cash holdings demonstrate responsiveness to regulatory and stakeholder pressures by reallocating financial resources toward compliance, innovation, and sustainability, thereby enhancing legitimacy and reducing reputational risk (Ioannou & Serafeim, 2017)**.** Collectively, these perspectives indicate that the observed decline in abnormal cash holdings reflects a combination of improved governance discipline, market signalling, and responsiveness to stakeholder demands under mandatory carbon disclosure.

Moreover, the reduction in abnormal cash holdings observed can also be connected to the rise in institutional ownership documented in my first empirical chapter (Chapter 3). Following the introduction of mandatory carbon disclosure, U.K. firms attracted a greater level of investment from institutional investors, particularly long-term, monitoring-oriented institutions and climate-conscious institutional investors. Prior research shows that institutional investors play a critical governance role by disciplining management, reducing information asymmetry, and curbing agency-driven behaviour (Dyck et al., 2019; Harford et al., 2008). An increase in institutional ownership enhances external monitoring and places pressure on managers to align liquidity policies with shareholder interests, particularly in the presence of long-term institutional investors. Harford et al. (2018) argue that monitoring by such investors strengthens governance and curbs managerial misbehaviour, including earnings management and financial fraud. In doing so, long-term investors tend to discourage opportunistic investment and financing activities while encouraging shareholder-oriented payouts. Rather than allowing cash balances to deviate substantially from optimal levels, managers are incentivised to reduce excess cash holdings to avoid scrutiny and reputational costs (Pinkowitz et al., 2006). The mechanism is thus one of enhanced governance; mandatory disclosure improves transparency, which attracts monitoring-oriented institutional investors, and this shift in ownership structure subsequently constrains managerial discretion over liquidity. This process leads to a measurable reduction in abnormal cash holdings, particularly excess cash, as firms allocate resources more efficiently and reduce the agency costs associated with idle cash reserves (Dittmar & Mahrt-Smith, 2007; Jensen, 1986). Overall, the findings across Chapters 3, 4 and 5 highlight the role of institutional investors as a key transmission channel through which disclosure regulation strengthens corporate governance and improves financial discipline.

Overall, the observed decline in abnormal cash holdings reflects an interplay of agency cost mitigation, market signalling, stakeholder responsiveness, and institutional investor oversight, underscoring the multifaceted impact of mandatory carbon disclosure on corporate financial behaviour. In the additional analysis section, I further examine to confirm whether the actual level of institutional ownership moderates the impact of the regulation on abnormal cash holdings by employing a difference-in-difference-in-differences (DiDiD) framework.

While abnormal cash holdings capture the absolute deviation of actual cash from optimal levels, this aggregate measure masks important differences between firms that hold too much cash (excess cash) and those that hold too little (insufficient cash). Prior research shows that the economic implications of these two conditions are distinct: excess cash is often associated with agency problems, as managers may hoard resources to pursue self-interested projects or avoid external monitoring (Dittmar & Mahrt-Smith, 2007; Harford et al., 2008; Jensen, 1986). In contrast, insufficient cash reflects liquidity shortfalls that can constrain investment, increase financial distress risk, and reduce firm value (Denis & Sibilkov, 2010; Oler & Picconi, 2014; Opler et al., 1999). Moreover, investors and capital markets interpret these deviations differently, with excess cash generally viewed as a sign of poor governance and potential resource misallocation, while insufficient cash signals financial vulnerability and financing constraints (Bates et al., 2009; Pinkowitz et al., 2006). Therefore, examining excess and insufficient cash separately provides a more nuanced understanding of how mandatory carbon disclosure affects firms' liquidity management. By separating these components, I am able to assess whether disclosure-induced governance pressure primarily reduces agency-driven cash hoarding or whether it also impacts firms' precautionary motives and their ability to meet liquidity needs under heightened regulatory scrutiny. In the next section, I extend the analysis by examining how mandatory carbon disclosure affects excess cash and insufficient cash separately.

5.5.2 The effect of mandatory carbon disclosure on excess and insufficient cash holdings

To provide deeper insight into how mandatory carbon disclosure shapes firms' liquidity management, I decompose abnormal cash holdings into their two underlying components: excess cash (cash balances above optimal levels) and insufficient cash (cash balances below optimal levels). Optimal cash is estimated using the model of Oler and Picconi (2014), as outlined in Section 5.3.2. This decomposition allows me to test whether the decline in abnormal cash holdings documented in Section 5.5.1 is primarily driven by reductions in managerial hoarding of excess cash, or whether it also reflects tighter cash management and leaner operations that could expose firms to liquidity shortfalls.

[Table 5-5 about here]

Table 5-5 reports the results of separating abnormal cash into excess and insufficient components. The interaction term *DiD (Treated × After)* is significant in both models but with opposite signs. For excess cash (Model 1), the coefficient is -0.0055, statistically significant at the 1% level, indicating that U.K. firms reduced their excess cash by about 20.83% (= 0.0055/0.0264; the average excess cash holdings of U.K. firms = 0.0264) relative to European firms after the regulation. This strong negative effect suggests that mandatory disclosure curtailed managerial incentives to hoard surplus cash, thereby strengthening corporate governance. In contrast, for absolutely insufficient cash (Model 2), the coefficient is 0.0024, significant only at the 10% level, implying a more modest 6.35% (= 0.0024/0.0378; the average insufficient cash holdings of U.K. firms = 0.0378) increase in cash shortfalls. Overall, the findings show that the reduction in abnormal cash holdings is primarily driven by the decline in excess cash, highlighting that disclosure and scrutiny are most effective in discouraging inefficient cash hoarding rather than amplifying liquidity shortages.

This effect can suggest that mandatory carbon disclosure promotes better cash management by both reducing hoarded resources and encouraging leaner operations. These findings also indicate that mandatory carbon disclosure not only reduces excess cash but also leads to more efficient allocation of cash resources, promoting financial discipline within firms, and mitigating agency conflicts and forcing managers to deploy resources more efficiently rather than hoarding them for unproductive uses. By limiting managers' ability to hoard excess cash for unproductive purposes, the regulation aligns cash management practices with shareholder interests by increasing institutional ownership after the regulation, addressing agency conflicts between managers and shareholders as highlighted by Jensen (1986).

Overall, this chapter highlights how environmental policy, specifically mandatory GHG disclosure, can influence corporate financial decision-making by mitigating agency problems and fostering more efficient cash management. The regulation not only curtails excess cash but also reduces the perceived need for precautionary reserves, suggesting that environmental transparency improves both governance and resource allocation.

5.6 Robustness checks

In this section, I conduct a series of robustness checks to validate the main findings, which indicate a statistically significant and negative relationship between mandatory carbon disclosure and abnormal cash holdings. To ensure the reliability of these results, I implement several additional tests. First, I conduct a falsification test by altering the timing of the disclosure regulation. Second, I create a pseudo-treatment dummy by randomly assigning firms to treatment and control groups to verify that the observed effects are not driven by other regulatory changes. Third, to address potential endogeneity concerns related to abnormal cash holdings, I re-estimate the main specification, Equation (5-4), by incorporating additional control variables identified in the literature as may influence firm-level cash holding behaviour. Fourth, I augment Equation (5-4) with firm-level, stock exchange-year, and industry-year fixed effects to account for time-invariant confounding factors in line with established empirical practices. Across all robustness checks, the results remain consistent and support the initial findings.

5.6.1 Falsification test on the timing of the carbon disclosure regulation

The main research findings indicate that the implementation of the U.K.'s GHG emissions disclosure regulation is associated with a decline in abnormal cash holdings. The baseline difference-in-differences (DiD) model relies on the key assumption that, in the absence of the regulation, the treatment and control groups would have followed parallel trends in their cash ratios. This implies that, without regulatory intervention, firms' approaches to cash management would not differ systematically between groups. However, this assumption may be violated if treatment and control firms exhibited divergent trends even prior to the regulation or if certain firms, particularly in specific sectors, adjusted their cash holdings in anticipation of the regulation based on prior knowledge or earlier policies.

To address these concerns, I follow the falsification test methodology used by Marshall et al. (2022) and Balachandran & Nguyen (2018). Specifically, I re-estimate the specification (5-4) over a placebo period from 2001 to 2010, treating 2006 as a regulatory shock year. The pre-treatment period is defined as 2001–2005 ($After_t = 0$), and the post-treatment period as 2006–2010 ($After_t = 1$). This allows me to test whether any significant changes in abnormal cash holdings occurred around a period with no actual regulatory change, thus isolating the effect of potential cyclical or external factors.

As shown in Table 5-6, the DiD coefficient reported in column (1) is not statistically significant. This suggests that the observed effects in the main analysis are unlikely to be driven by underlying trends or anticipatory adjustments. Overall, the falsification test supports the validity of the parallel trends assumption and reinforces the conclusion that the main findings are not confounded by pre-existing trends or external shocks unrelated to the U.K.'s mandatory carbon disclosure regulation.

[Table 5-6 about here]

5.6.2 Pseudo treatment

As a further robustness check, I construct a pseudo-treatment dummy by randomly assigning firms to either the treatment or control group. The number of firms in the treatment group is aligned with my primary analysis, which distinguishes between those that complied with the U.K. carbon disclosure regulation and those that did not. I repeat this exercise across five different random specifications to ensure that the results are not driven by spurious correlations. I assign the dummy variable *Treated* a value of one for firms randomly designated as compliant with the regulation, and zero otherwise. Using the methodology outlined in Krueger (2015), I apply all five models over the 2008–2018 period. As shown in Table 5-7, the interaction term *DiD (Treated × After)* is statistically insignificant in all five models. These findings confirm that when treatment status is randomly allocated, no meaningful effect on abnormal cash holdings is detected. This reinforces the validity of my main results by demonstrating that the documented reduction in abnormal cash holdings is not an artefact of the estimation strategy but instead reflects the causal effect of the mandatory carbon disclosure regulation.

[Table 5-7 about here]

5.6.3 Additional control variables

To address potential concerns related to omitted variable bias, the primary analysis is re-estimated by incorporating additional control variables used in the literature: Market to Book value ratio (MTB), Dividend Payment, R&D Expenditure, Debt Issuance, and Equity Issuance (i.e. Chen et al., 2020; Choi et al., 2018; Faulkender & Wang, 2006; Pinkowitz et al., 2012). Table 5-8 presents the results, indicating that the coefficient for the variable of interest (DiD) remains negative and statistically significant at the 1% level, reinforcing the robustness of the main findings and supporting the validity of my hypothesis even after including these additional covariates.

[Table 5-8 about here]

Dividend payments are included following Faulkender and Wang (2006), who argue that dividend policy affects corporate cash holdings by influencing the allocation of internal funds. The results indicate a positive and statistically significant relationship between dividend payments and abnormal cash holdings. Higher dividends reflect firms' efforts to return cash to shareholders under greater transparency and investor monitoring. This outcome aligns with the literature suggesting that dividend policy and cash holdings are jointly determined financial decisions (Faulkender & Wang, 2006; Pinkowitz et al., 2006), and reinforces the idea that mandatory disclosure shapes both dimensions of firms' financial behaviour simultaneously. Similarly, R&D expenditures are added as they serve as a proxy for growth opportunities (Pinkowitz et al., 2012). R&D-intensive firms typically face higher financing frictions and may hold more cash as a buffer due to the limited collateral value of intangible assets and the greater difficulty in obtaining external funding for innovation-related expenses.

Debt and equity issuance are also incorporated to capture firms' financing behaviour. Debt issuance provides immediate liquidity, potentially reducing the need for precautionary cash holdings. It can also be a strategy to secure future credit capacity in environments with uncertain access to capital (Kling, 2018; Sun & Xia, 2022). On the other hand, equity issuance is often driven by market timing motives. Firms, especially those already holding substantial cash, may issue equity when their stock is perceived as overvalued, using the proceeds for strategic investments or acquisitions that could reduce short-term cash reserves (Chen et al., 2024).

In line with prior research, I exclude the market-to-book (MTB) ratio from the main specification due to its conceptual ambiguity. MTB shows a reflection of both growth opportunities (e.g. Smith & Watts, 1992), which would predict a positive relationship with cash holdings, and access to capital markets (e.g. Baker & Wurgler, 2002), which implies a negative relationship. To circumvent this theoretical tension, I instead include sales growth as a cleaner proxy for firm-level growth opportunities.

5.6.4 Control for time-invariant confounding factors

To account for time-invariant confounding factors and mitigate unobserved heterogeneity that might bias the results, I incorporate firm-level, stock exchange-year, and industry-year fixed effects into Equation (5-4), following prior literature (e.g. Alexander et al., 2024; Jouvenot & Krueger, 2019). Drawing on the insights from literature, I address the potential endogeneity concern arising from unobservable factors such as internal information quality that may influence firms' cash holding behaviour. The inclusion of firm fixed effects controls for all time-invariant firm-level heterogeneity, thereby helping to isolate the causal effect of the U.K. carbon disclosure regulation.

Stock exchange-year fixed effects are included to account for time-varying factors specific to each stock exchange that may influence both carbon disclosure practices and firms' cash holding behaviour. These factors can include changes in listing regulations, economic conditions, market sentiment, and broader financial trends (Jouvenot & Krueger, 2019). This control is particularly important in studies that span multiple exchanges or jurisdictions, where regulatory environments and investor expectations around environmental transparency can differ significantly (Downar et al., 2021; Rehman et al., 2021). For example, exchanges with stricter regulatory oversight or more environmentally conscious investor bases may exert pressure on firms to disclose more, which in turn could impact how these firms manage liquidity and hold cash (Gerged et al., 2021). Similarly, industry-year fixed effects are included to capture variation across industries and over time, controlling for sector-specific trends such as economic cycles, policy changes, or technological advancements (Zhang et al., 2024). Prior research indicates that firms operating in more heavily regulated industries tend to hold higher levels of cash as a precautionary measure against regulatory or operational uncertainty (Chen et al., 2024). Including industry-year fixed effects helps mitigate bias from these dynamic industry-level influences that might otherwise confound the estimated effect of carbon disclosure regulation on abnormal cash holdings.

[Table 5-9 about here]

The regression results, reported in Table 5-9, remain consistent with those from the baseline model. This reinforces the robustness of the findings and suggests that the observed effects are not driven by unobserved firm-level heterogeneity or contextual differences across industries and stock exchanges.

5.7 Additional analyses

5.7.1 Does the Treatment Effect Vary with the Level of GHG Emissions?

The preceding analysis examines the average response of U.K. firms to the mandatory carbon disclosure regulation, particularly in relation to their cash management behaviour. However, it is reasonable to expect that the regulation's impact may differ across firms depending on their observable characteristics. In particular, firms' levels of GHG emissions and the extent of external investor pressure are likely to influence how they adjust following the implementation of the disclosure mandate. This potential heterogeneity is consistent with prior literature suggesting that firms with higher emissions face greater scrutiny from investors and other stakeholders, which may amplify the regulatory effect on corporate financial and strategic decisions (Bolton et al., 2021; Krueger et al., 2020)

A growing strand of research highlights that the financial implications of environmental regulation are not uniform across firms but rather depend on their underlying carbon intensity. High-emission firms face greater scrutiny from regulators, investors, and stakeholders, which heightens their exposure to reputational and regulatory risks, which in turn can shape their financial policies in ways distinct from their low-emission peers (Bolton & Kacperczyk, 2021a; Ilhan et al., 2021). In particular, cash management represents a key margin of adjustment; high-emission firms may hold cash differently because they anticipate higher compliance expenditures or litigation risks, but they may also come under stronger investor and stakeholder monitoring that limits managerial discretion. Accordingly, it is important to test whether the observed treatment effect of mandatory carbon disclosure on abnormal cash holdings varies according to firms' emission levels, as emissions could act as an intermediate channel magnifying or dampening the regulation's impact.

From a theoretical perspective, carbon emissions can be seen as a conditioning mechanism that interacts with agency and stakeholder pressures. High-emission firms often exhibit weaker governance and higher information asymmetry, making their cash holdings more prone to agency conflicts (Amin et al., 2024). However, mandatory disclosure enhances transparency and empowers institutional investors and other stakeholders to scrutinise these firms more effectively (Dyck et al., 2019). This duality suggests that abnormal cash holdings are not only a function of regulatory change but also of firms' environmental profiles, with carbon intensity operating as a mediating variable. Studying this heterogeneity provides deeper insight into how climate regulation shapes financial discipline, while low-emission firms may adjust moderately, high-emission firms are expected to exhibit stronger reductions in abnormal cash holdings as a signal of compliance and in response to heightened monitoring pressures.

To examine this conjecture, I analyse whether firms' responses to the regulation vary according to their level of GHG emissions. To address this within the treated sample, I employ a double difference-in-differences (DiDiD) approach using specification (5-5), which leverages cross-sectional variation in a carbon emissions dummy variable.

$$Y_{it} = \alpha + \beta_1 . (Treated_i \times After_t \times Industry_{it}) + \beta_2 . (Treated_i \times After_t) + \beta_3 . Treated_i + \beta_4 . After_t + \beta_5 . \boldsymbol{X}_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it} \qquad (5\text{-}5)$$

I estimate specification (5-5) to evaluate the impact of the level of carbon emissions on the treatment group following the implementation of the regulation. To begin, I define the *Industry* variable as a binary indicator that equals one if a firm's carbon intensity is higher than the peer group median and zero otherwise. Carbon intensity is calculated as the actual level of carbon emissions (in thousand tons) divided by the firm's revenue (in millions of USD). The dependent variable, Y_{it}, serves as abnormal cash holdings for firm i in year t. The remaining variables are defined as outlined in Model (5-4).

The results reported in Table 5-10 reveal a statistically significant negative relationship, with a coefficient of -0.0048 at the 1% level, indicating that U.K. firms operating in high-emission industries are more likely to reduce their abnormal cash holdings following the implementation of the mandatory carbon disclosure regulation. From an economic perspective, this translates to an approximate 7.45% reduction in abnormal cash holdings relative to the average level (calculated as 0.0048 / 0.0644 = 7.45%) when compared to firms in low-emission industries. This finding is consistent with existing literature, which suggests that firms adjust their financial strategies in response to climate-related risks and environmental regulations (Chang et al., 2024; Kovacs et al., 2021). In line with this, existing research of Amin et al. (2024) finds that firms with higher emission levels tend to maintain lower abnormal cash holdings, potentially due to weaker internal governance, greater information asymmetry, and CEO overconfidence. These firms are also more inclined to allocate funds toward capital investments while reducing expenditures on R&D. This behaviour is consistent with agency theory, suggesting that high-emitting firms may intentionally hold less cash to avoid external monitoring and to pursue suboptimal investment opportunities that benefit management rather than shareholders.

[Table 5-10 about here]

5.7.2 Does institutional ownership matter to cash holdings behaviour?

Institutional investors often view excess cash holdings as a potential agency problem, where managers might misuse funds rather than invest in value-enhancing projects. This perspective can lead to pressure on firms to reduce excess cash and allocate resources more efficiently. Lu et al. (2017) suggest that carbon emissions reports provide valuable information that enhances monitoring, thus inducing more efficient use of cash holdings. In my empirical framework under Specification (5-6), treatment firms with varying levels of institutional ownership- high and low may exhibit different impacts on firm-level abnormal cash holdings.

My previous research on the effects of mandatory carbon disclosure on institutional ownership indicates that firms complying with carbon disclosure regulations tend to attract greater investment from institutional investors, consistent with the findings of Marshall et al. (2022). Literature suggests that institutional investors can alleviate financial constraints by enhancing corporate governance, reducing information asymmetry, and shaping capital structure decisions (e.g. Chung et al., 2010; Schain & Stiebale, 2021). Their presence can reduce the need for firms to hold large precautionary cash reserves, as access to external financing becomes less constrained. Moreover, the implementation of mandatory carbon disclosure often compels firms to lower their emissions in response to growing pressure from institutional investors, stakeholders, and competitors. Hence, institutional ownership and mandatory disclosure regulations may interact to shape firms' corporate cash management decisions.

To address this potential concern within the treated firms, I employ a DiDiD framework, as specified in Equation (5-6). This extended design leverages cross-sectional variation in institutional ownership levels to capture heterogeneous treatment effects and to better isolate the causal impact of the disclosure regulation.

$$Y_{it} = \alpha + \beta_1 . (Treated_i \times After_t \times IO_{it}) + \beta_2 . (Treated_i \times After_t) + \beta_3 . Treated_i + \beta_4 . After_t + \beta_5 . \boldsymbol{X}_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it} \quad (5\text{-}6)$$

I estimate specification (5-5) to examine the impact of the actual level of institutional ownership on the treatment group following the regulation. The IO variable is defined as the actual percentage level of institutional ownership. The results of specification (5-6) are presented in Table 5-11. The Y_{it} is the proxy variable for Abnormal cash holdings, Excess cash holdings, and Absolute insufficient cash holdings for firm i in year t. The remaining variables are defined as outlined in Model (5-4).

[Table 5-11 about here]

The empirical results reveal that the coefficient on the triple interaction term $Treated_i \times After_t \times IO_{it}$ (*DiDiD*) is negative and statistically significant at the 1% level in both specifications for abnormal cash holdings (column 1) and excess cash holdings (column 2). Conversely, the coefficient is positive and significant at the 1% level for absolutely insufficient cash holdings (column 3). These findings suggest that, in the post-regulation period, higher levels of institutional ownership are associated with a reduction in abnormal and excess cash holdings among treated firms, relative to control firms. In contrast, institutional ownership is linked to an increase in absolute insufficient cash holdings, indicating a tighter cash position.

The reduction in abnormal cash holdings following mandatory carbon disclosure can be understood through the moderating role of institutional ownership. As demonstrated in the first empirical chapter of this thesis, firms that actively reduce their carbon emissions attract greater institutional investment after the mandate, particularly from long-term, independent, and sustainability-oriented investors. This shift in ownership structure strengthens external monitoring and governance discipline, creating direct pressure on managers to deploy cash more efficiently. In line with agency theory, excess cash holdings are often associated with managerial discretion and potential misuse of resources for empire-building or private benefits (Harford et al., 2008; Jensen, 1986). The presence of strong institutional investors constrains these agency problems, reducing managers' ability to hoard abnormal cash. Thus, the post-regulation inflow of institutional investment into compliant firms not only represents a reallocation of financial resources in capital markets (Chapter 3) but also a new determinant of firm-level liquidity policy by reinforcing the governance function of shareholders.

Importantly, this mechanism extends prior literature by linking environmental disclosure, institutional ownership, and cash management into a unified framework. While earlier research documents that institutional investors influence payout policies and capital allocation, this study highlights that their role becomes even more prominent when coupled with climate regulation. Mandatory disclosure enhances transparency and comparability, enabling institutional investors to identify firms with genuine commitments to emissions reduction and to reward them with increased ownership stakes. Once invested, these institutions push for more disciplined cash policies, encouraging managers to reduce abnormal cash holdings and reallocate resources toward shareholder-aligned or climate-resilient uses (W. Chen et al., 2024; Cohen et al., 2023). This mechanism represents a novel contribution to the determinants of cash management; not only do regulatory pressures matter, but the *composition of ownership* shaped by these regulations plays a critical role in constraining excess liquidity. Hence, institutional ownership operates as the transmission channel through which disclosure regulation translates into tangible changes in firms' cash policies, bridging the findings of the first and third of my empirical chapters.

5.7.3 Does investment horizon matter to cash holdings behaviour?

The main empirical results show that mandatory carbon disclosure is associated with significant changes in firms' cash holdings. Additional analysis further reveals that institutional ownership plays a moderating role in reducing abnormal cash holdings, yet the strength and direction of this effect are likely to depend on the investment horizon of institutional investors. As documented in Chapter 3 (my first empirical chapter), firms that actively reduce their carbon emissions attract greater ownership from long-term, independent, and sustainability-oriented investors following the mandate. This ownership shift is critical because long-term investors have both the incentive and the ability to monitor managers effectively, aligning corporate decisions with shareholder value. Prior research shows that such investors improve governance by curbing opportunistic behaviours, such as earnings manipulation and financial fraud, while discouraging wasteful investment and risky financing (Harford et al., 2018). Moreover, they are more likely to encourage the redirection of excess cash toward sustainability-oriented projects that enhance long-term firm value, even if these do not generate immediate financial returns (Cohen et al., 2023; Kordsachia et al., 2022). In this way, the presence of long-term investors strengthens the disciplining role of disclosure regulation, making cash management more strategic and aligned with sustainable growth.

By contrast, when firms are primarily monitored by short-term or transient investors, the consequences of mandatory disclosure for cash policies may differ markedly. Short-term investors tend to prioritise immediate returns and portfolio turnover, limiting their monitoring capacity and sometimes encouraging managerial myopia (Bolton et al., 2006; Bushee, 1998; Stein, 1989). Evidence suggests that their presence is linked to reduced R&D spending, higher leverage, and greater payouts (Cremers & Pareek, 2016), although they may also enhance innovation efficiency (Brav et al., 2018) and resilience during economic downturns (Giannetti & Yu, 2021). Overall, these findings suggest that the impact of mandatory carbon disclosure on abnormal cash holdings cannot be fully understood without accounting for the investment horizon of institutional owners. Drawing on the evidence presented in Chapter 3, which shows that long-term investors are drawn to emission-reducing firms post-mandate, this chapter provides evidence that such investors are not only capital providers but also governance enforcers who shape firms' liquidity choices. Thus, institutional investment horizons emerge as a new and important determinant of cash management in the context of environmental regulation.

To mitigate this potential concern within the treated group, I apply a DiDiD approach, as specified in Equation (5-7). This method exploits cross-sectional variation in long-term institutional ownership levels to capture heterogeneous treatment effects and to better identify how persistent institutional investors respond to the disclosure regulation.

$$Y_{it} = \alpha + \beta_1 . (Treated_i \times After_t \times Type_{it}) + \beta_2 . (Treated_i \times After_t) + \beta_3 . Treated_i + \beta_4 . After_t + \beta_5 . \boldsymbol{X}_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it} \quad (5\text{-}7)$$

I estimate specification (5-7) to examine the impact of different types of institutional ownership on abnormal cash holdings in the treatment group following the regulation. The variable *Type* serves as a proxy, representing the actual percentage of firm-level ownership held by either long-term or short-term institutional investors. The results of specification (5-7) are presented in Table 5-12. The dependent variable, Y_{it}, represents the abnormal cash holdings for firm i in year t.

[Table 5-12 about here]

The empirical findings show that the coefficient on the triple interaction term *Treated × After × Type* (DiDiD) of model (1) is -0.0002 and statistically significant at the 1% level (column 1), indicating that, after the implementation of the mandatory carbon disclosure regulation, treated firms with higher levels of long-term institutional ownership significantly reduced their abnormal cash holdings. In contrast, model (2) reports a coefficient of 0.0014, also significant at the 1% level, suggesting that firms with predominantly short-term institutional investors experienced a statistically significant increase in abnormal cash holdings in the post-regulation period. These results highlight a clear divergence in firms' financial responses based on the investment horizon of their institutional shareholders. Consistent with prior literature, firms with short-term-oriented institutional investors tend to accumulate more cash as a precautionary measure to hedge against financial volatility and limited access to external financing. In contrast, long-term institutional investors are associated with lower levels of cash holdings, reflecting their emphasis on sustainable value creation and reduced sensitivity to short-term market fluctuations (Christine et al., 2011).

In summary, the evidence demonstrates that the investment horizon of institutional investors is a key factor shaping firms' cash management responses to mandatory carbon disclosure. Firms monitored by long-term institutional investors reduce abnormal cash holdings, as these investors exert effective monitoring, discourage short-term opportunism, and redirect resources toward sustainable value creation. By contrast, firms dominated by short-term investors show an increase in abnormal cash reserves, reflecting greater sensitivity to short-term risks and liquidity concerns. These contrasting effects highlight the dual role of institutional ownership: it can either strengthen the disciplining force of disclosure regulation or reinforce managerial short-termism, depending on investor time horizons. Overall, the findings underscore that mandatory carbon disclosure not only reshapes ownership structures but also amplifies the importance of distinguishing between long-term and short-term investors in understanding corporate liquidity strategies under environmental regulation.

5.8 Conclusion

This chapter examines how mandatory carbon disclosure affects firms' cash management policies, using the introduction of the U.K. carbon disclosure mandate as a quasi-natural experiment. Applying a difference-in-differences design with European firms as the control group, the analysis provides consistent evidence that U.K.-listed firms significantly reduced their abnormal cash holdings following the regulation. The reduction is economically meaningful equivalent to an average decrease of around 4.66% in abnormal cash and remains robust across various model specifications, placebo tests, additional controls, and adjusted fixed effects. Decomposition shows this effect is driven by a sizable fall in excess cash

(20.83%), while insufficient cash rises modestly and only weakly (6.35%). Together, these patterns indicate that transparency primarily curbs hoarding rather than creating pervasive liquidity shortfalls. The results align with agency theory and the information-asymmetry view: mandatory disclosure improves transparency, strengthens external monitoring, and limits managerial discretion over liquidity, thereby reducing agency-driven excess cash. They are also consistent with the signalling theory: disciplining excess balances and reallocating resources toward productive or distributive uses credibly signals financial discipline and long-term value creation.

Further analyses reveal that the effect of disclosure is not uniform across firms. High-emission firms experience larger reductions in abnormal and excess cash holdings, suggesting that greater public scrutiny and compliance costs intensify monitoring pressure. However, these firms also show some increase in insufficient cash holdings, indicating a trade-off between tighter discipline and reduced financial flexibility. In contrast, low-emission firms exhibit stronger payout responses (the empirical results from Chapter 4), implying that they redirect freed cash toward shareholder distributions rather than retaining idle balances.

Ownership structure also plays an important moderating role. Firms with higher institutional ownership demonstrate sharper declines in abnormal cash, highlighting that informed and active investors amplify the governance benefits of disclosure. The nature of institutional investors further shapes this effect. Importantly, the investment horizon of institutional investors moderates this relationship. Long-term institutional investors amplify the disciplining impact of disclosure, driving firms toward lower abnormal cash balances and more efficient liquidity management. In contrast, short-term investors tend to weaken this effect by encouraging precautionary cash accumulation and short-term decision-making. This finding indicates that not all institutional ownership exerts the same governance influence; its impact depends critically on investors' time horizons and engagement strategies.

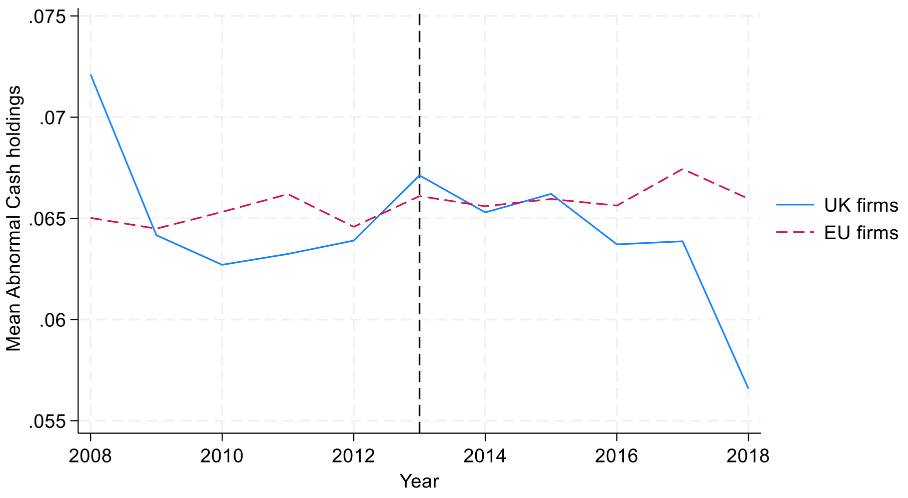
Collectively, these findings show that mandatory carbon disclosure not only enhances firms' environmental transparency but also influences their core financial policies. By reducing information asymmetry and strengthening external monitoring, disclosure limits managerial discretion over liquidity and promotes more efficient cash management. The evidence thus extends the literature on both disclosure regulation and corporate cash policy, demonstrating that non-financial reporting requirements can have meaningful financial consequences through governance channels.

From a policy perspective, the results suggest that carbon disclosure mandates can improve financial discipline and investor confidence. However, the heterogeneous responses across emission intensities and ownership structures indicate that the impact of such regulation depends on firm characteristics and investor composition. For firms and investors alike, the findings emphasise that environmental transparency is not merely a compliance exercise; it is a governance mechanism that shapes liquidity decisions, payout policies, and long-term value creation. In summary, this chapter provides robust evidence that mandatory carbon disclosure reduces agency-driven excess cash holdings and fosters more efficient liquidity management. However, the diversity of firm responses underscores that the benefits of disclosure depend on how transparency interacts with environmental performance, ownership structure, and investor horizons.

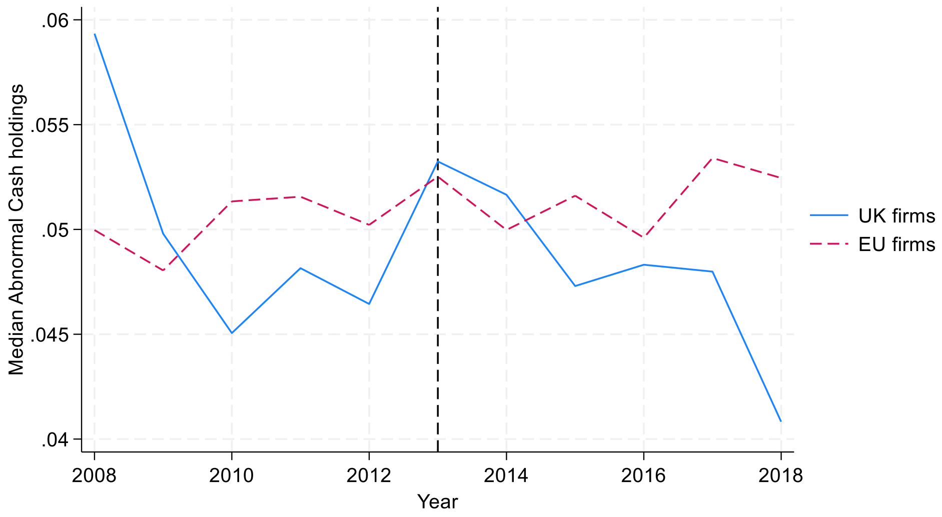
Figure of Chapter 5

Figure 5-1

This figure reports the annual mean (Panel A) and median (Panel B) of abnormal cash holdings (ABCASH) for the sample of European firms from 2008 to 2018. Abnormal cash holdings are calculated as the absolute deviation between actual cash holdings and predicted (optimal) cash levels based on the baseline cash regression in Table 5-2.



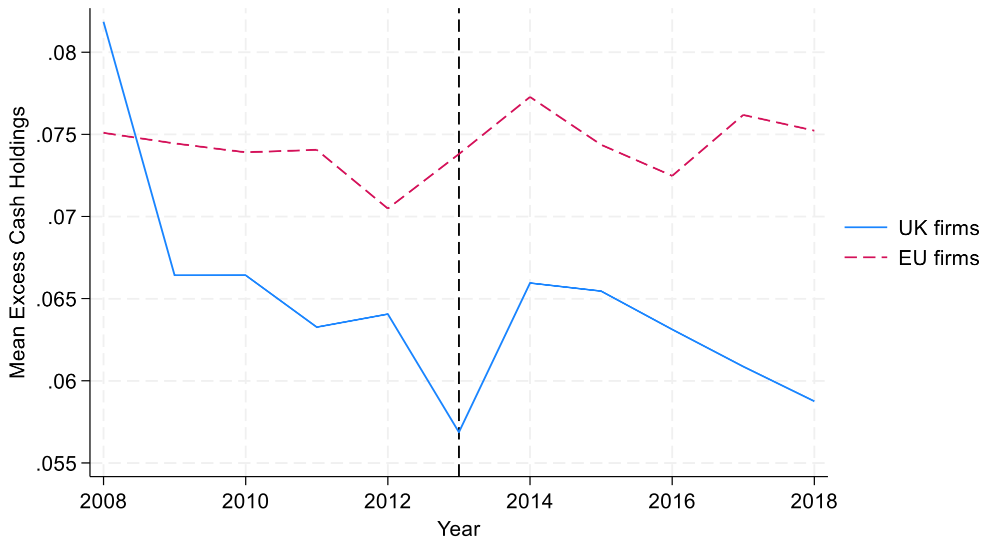
Panel A. Mean Abnormal Cash Holdings



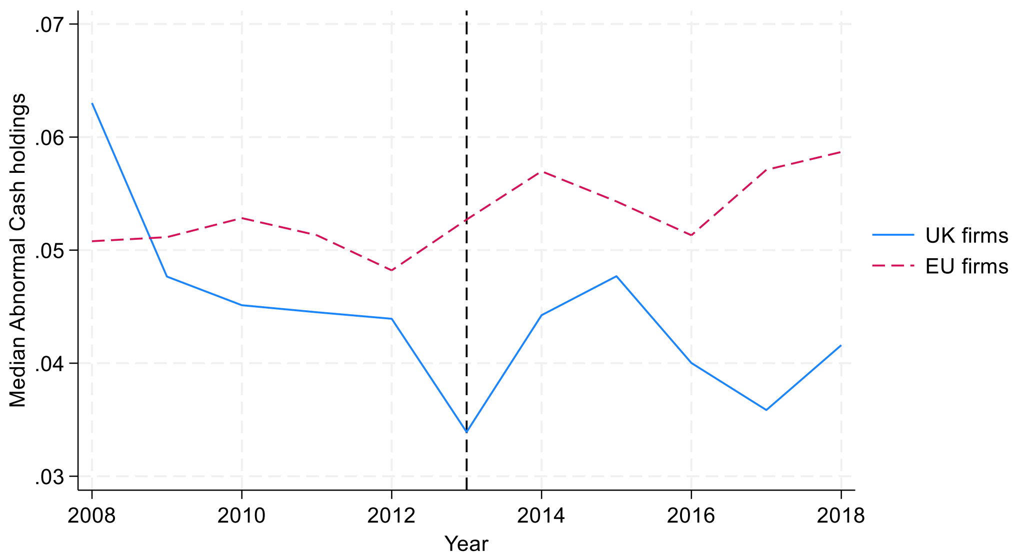
Panel B. Median Abnormal Cash Holdings

Figure 5-2 Distribution of Excess Cash Holdings

This table reports the annual mean (Panel A) and median (Panel B) of excess cash holdings for the sample firms from 2008 to 2018. Excess cash holdings are calculated as the positive value of deviation between actual cash ratios and predicted (optimal) cash levels estimated from the baseline cash regression. The table provides descriptive evidence on the magnitude and time-series variation of deviations from optimal corporate cash policies.



Panel A. Mean Excess Cash Holdings



Panel B. Median Excess Cash Holdings

Figure 5-3 Difference in abnormal cash holdings between U.K. firms (treatment group) and European firms (control group) around the introduction of the regulation

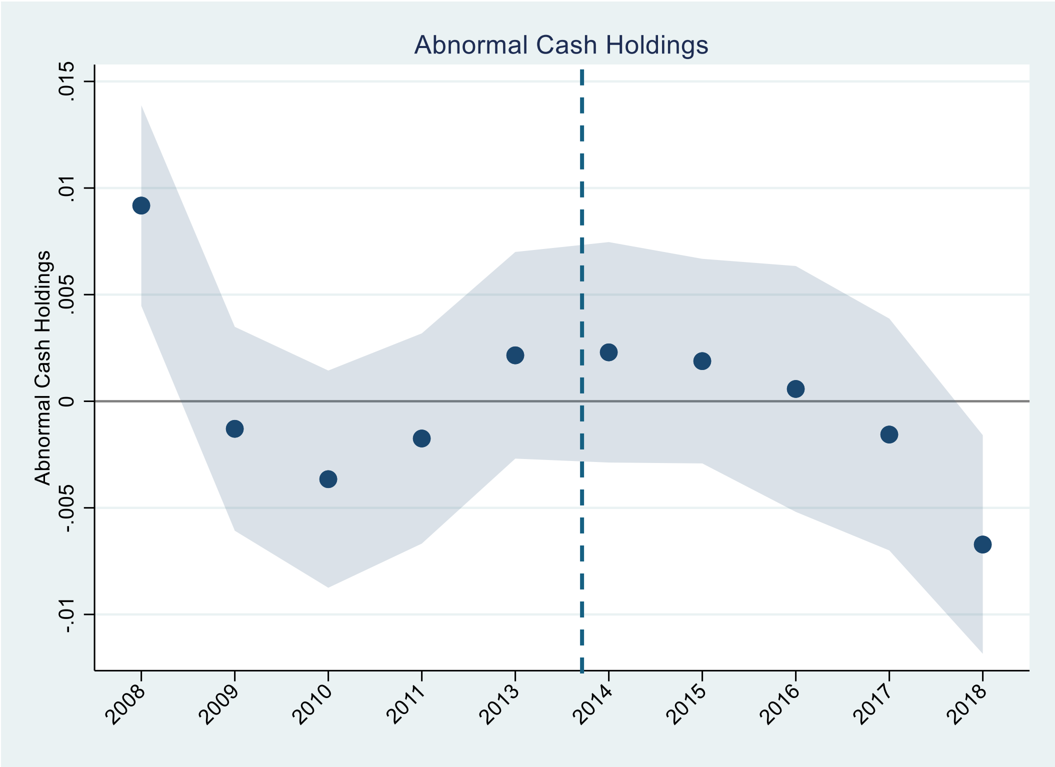


Figure 5-3 illustrates the parallel trend assumption test derived from the event-study regression. The coefficients plotted correspond to the interaction terms between the treatment group (U.K. firms) and each year, relative to the pre-policy base period. The shaded region represents the 95% confidence intervals. The results indicate that pre-treatment coefficients (2009-2012) are statistically indistinguishable from zero and clustered closely around the horizontal axis. This pattern suggests that, prior to the enactment of the greenhouse gas (GHG) disclosure mandate, treated and control firms followed similar trajectories in abnormal cash holdings**.** Hence, no significant differences in cash holdings behaviour existed between the two groups before the policy change. These findings lend strong support to the parallel trend assumption, which is a critical identifying condition for the Difference-in-Differences (DiD) estimation framework.

Tables of Chapter 5

Table 5-1 Sample selection

This table presents the sample selection procedure for the analysis of cash holdings policy. The sample period is 2008–2018.

Step of sample selection procedure	Firms	Firm-year
All firm-year observations for listed firms in European countries from S&P Capital IQ (2008–2018)	6,951	76,461
Exclude financial firms (SIC 6000–6999)	5,855	64,405
Exclude firms with total assets < 100USD mm	1,601	17,611
Exclude firms with missing required information for calculating optimal cash holdings	1,335	14,685

Table 5-2 Baseline normal cash holdings analysis

This table reports the regression results for the level of cash used to compute normal (optimal) cash holdings as per the following specification:

$Cash_{it} = \alpha + \beta_1.CF_{it} + \beta_2.NWC_{it} + \beta_3.Capex_{it} + \beta_4.Lev_{it} + \beta_5.RD_{it} + \beta_6.Div_{it} + \beta_7.MA_{it} + \beta_8.Age_{it} + \gamma_s + \tau_t + \lambda_n + \varepsilon_{it}$

where $Cash_{it}$ is the main dependent variable, that is, the natural logarithm of the ratio of cash divided by total assets for firm i in year t. The regressors include earnings before interest and taxes to total assets (CF), net working capital to total assets (NWC), research and development expenditures to total assets (RD), capital expenditures to total assets (Capex), total debt to total assets (Lev), total dividend paid over total assets (Div), and natural logarithm firm age (Age), all as defined in appendix A. γ_s, τ_t, and λ_n allow for year- stock exchange- and industry effects, respectively. All continuous variables are winsorized at 1% and 99% levels. Standard errors are clustered at the firm level, and t-stats are presented in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1% significance levels, respectively. The study period ranges from 2007 to 2011, which is the 5 years period before the year of the introduction of regulation.

Dependent variable: Cash holdings/ta	(1)
CF	0.2029***
	(5.3304)
NWC	0.3373***
	(17.5619)
Capex	-0.1188**
	(-2.5717)
Lev	0.0427***
	(2.9805)
RD	0.4828***
	(5.2292)
Div	0.1242*
	(1.7709)
M&A	-0.0488**
	(-2.4795)
Age (log)	-0.0057**
	(-2.2928)
Observations	6,395
R-squared	0.5359
Industry FE	Yes
Year FE	Yes
Country FE	Yes

Table 5-3 Descriptive statistics

This table reports descriptive statistics for all variables used in the analysis. Panel A presents the number of firm-year observations, mean, median, standard deviation (SD), and the 10th and 90th percentiles, providing an overview of the distribution and variability of the sample data. Panel B displays the correlation matrix, which summarises the pairwise relationships among the key variables. The sample includes firms from European countries over the period 2008–2018. All continuous variables are winsorized at the 1st and 99th percentiles. The detailed definitions and measurement procedures for all variables are provided in Appendix 5-A1.

Variables	Obs.	Mean	Median	SD	P10	P90
Panel A: Descriptive statistics						
Main dependent variables:						
ABCAh	14285	.0655	.0507	.0586	.0096	.1384
ABCASH (raw in USD mm)	14285	304.5037	46.3234	892.7614	5.4403	668.6989
Excess cash	14285	.0325	0	.0598	0	.1061
Insufficient cash (absolute)	14685	.0321	.008	.0444	0	.0956
Cash ratio	14632	.1142	.0848	.1001	.0199	.2491
Carbon emissions variables (thousand tons)						
Total emissions (log)	7611	6.3532	6.2185	1.8797	4.0188	8.9711
Carbon emissions scope 1 (log)	7611	4.0253	3.6515	2.2643	1.3953	7.3698
Total carbon intensity	7611	.4087	.2243	.646	.063	.8592
Carbon Intensity Scope 1	7611	.1405	.0166	.4993	.0026	.261
Control variables						
Total asset (in USD mm)	14685	6542.4614	947.2778	18477.249	175.3326	12863.8
Cash Flow/TA	14584	.0614	.0527	.0523	.0089	.1255
Net Working Capital/TA	14584	.1445	.1329	.1741	-.0641	.3737
Sales growth %	14685	7.3725	5.2264	17.4914	-8.674	25.3289
Capital Expenditure/TA	14584	.0429	.033	.0372	.0074	.0916
Leverage (TD/TA)	14584	.5549	.5637	.1787	.3111	.7737
Firm Age (log)	14312	5.0108	5.0943	.8966	3.8332	6.0499
M&A/TA	14584	.0176	.0002	.0416	0	.0537
Additional controls						
Market-to-book value ratio	14632	1.5379	1.2648	.9338	.7939	2.6089
RD/TA	14584	.015	0	.0318	0	.0477
Div/TA	14632	.0249	.0164	.0305	0	.0588
Debt Issuance/TA	14632	.0683	.0284	.106	0	.1865
Equity Issuance/TA	14632	.0057	0	.0217	0	.0077

Panel B: Correlation matrix														
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) ABCASH	1.000													
(2) Total carbon intensity	-0.062	1.000												
	(0.000)													
(3) Cash Flow/TA	0.144	-0.085	1.000											
	(0.000)	(0.000)												
(4) Net Working Capital/TA	0.323	-0.003	0.244	1.000										
	(0.000)	(0.799)	(0.000)											
(5) Sales growth %	0.035	-0.010	0.205	0.035	1.000									
	(0.000)	(0.392)	(0.000)	(0.000)										
(6) Capital Expenditure/TA	-0.073	0.142	0.136	-0.130	0.050	1.000								
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)									
(7) Leverage (TD/TA)	-0.068	-0.102	-0.259	-0.498	-0.008	-0.054	1.000							
	(0.000)	(0.000)	(0.000)	(0.000)	(0.304)	(0.000)								
(8) Firm Age (log)	-0.043	0.054	-0.047	0.025	-0.115	-0.035	0.051	1.000						
	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)							
(9) M&A/TA	-0.087	-0.077	0.041	-0.104	0.161	-0.099	0.071	-0.018	1.000					
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.036)						
Additional controls														
(10) MB	0.100	-0.159	0.657	0.109	0.092	0.068	-0.105	-0.019	0.092	1.000				
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.025)	(0.000)					
(11) RD/TA	0.046	-0.121	0.205	0.168	0.009	-0.028	-0.108	-0.017	0.052	0.286	1.000			
	(0.000)	(0.000)	(0.000)	(0.000)	(0.251)	(0.001)	(0.000)	(0.040)	(0.000)	(0.000)				
(12) Div/TA	0.092	-0.072	0.614	0.137	-0.051	0.086	-0.177	0.008	-0.001	0.562	0.137	1.000		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.344)	(0.877)	(0.000)	(0.000)			
(13) Debt Issuance/TA	-0.062	0.097	-0.062	-0.154	0.117	0.117	0.214	-0.076	0.244	-0.039	-0.071	-0.032	1.000	
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
(14) Equity Issuance/TA	-0.004	-0.017	-0.023	0.009	0.093	-0.007	0.001	-0.068	0.187	0.040	0.025	-0.055	0.055	1.000
	(0.620)	(0.134)	(0.005)	(0.293)	(0.000)	(0.432)	(0.860)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	

Notes: Parentheses denote the significance levels.

Table 5-4 Main result: Abnormal cash holdings

This table reports the results from the difference-in-differences (DiD) estimation examining the effect of mandatory carbon disclosure on firms' abnormal cash holdings. The analysis is based on the following regression specification:

$$ABCASH_{it} = \alpha + \beta_1.(Treated_i \times After_t) + \beta_2.Treated_i + \beta_3.After_t + \beta_4.X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

In this model, $ABCASH_{it}$ is the dependent variable, defined as the absolute deviation of a firm's actual cash holdings from its predicted or optimal cash level in year *t*. The key coefficient of interest is β_1, which captures the causal impact of the mandatory carbon disclosure regulation on firms' abnormal cash holdings. The variable *Treated* equals one for firms subject to the U.K. GHG disclosure requirement and zero otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes firm-level control variables lagged by one year. The definitions and construction of these variables are provided in Appendix Table 5-A1. The regression includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The analysis covers the period 2008–2018.

Dependent variable: Abnormal cash holdings	(1)	(2)
DiD (Treated × After)	-0.0024**	-0.0030***
	(-2.1224)	(-2.8805)
After	-0.0014	-0.0017
	(-0.4892)	(-0.6985)
Treated	0.0004	-0.0021
	(0.1212)	(-0.6481)
CF		0.1003***
		(5.4871)
NWC		0.1370***
		(16.4315)
Sales Growth		-0.00003
		(-0.8123)
Capex		-0.0516**
		(-2.5297)
Lev		0.0439***
		(5.5270)
Age		-0.0004
		(-0.2022)
MA		-0.0285***
		(-3.1260)
Observations	14,285	14,148
R-squared	0.2304	0.3232
Industry FE	Yes	Yes
Year FE	Yes	Yes
Stock exchange FE	Yes	Yes

Table 5-5 Main result: Excess cash and absolute insufficient cash

This table reports the results from the DiD estimation examining the effect of mandatory carbon disclosure on the excess cash and absolute insufficient cash. The analysis is based on the following regression specification:

$$Y_{it} = \alpha + \beta_1.(Treated_i \times After_t) + \beta_2.Treated_i + \beta_3.After_t + \beta_4.X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

In this model, Y_{it} represents the dependent variable, which serves as a proxy for firms' excess and insufficient cash holdings (measured in absolute terms) for firm *i* in year *t*. The variable *Treated* is a dummy indicator that equals one for firms subject to the U.K. mandatory carbon disclosure regulation and zero otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes firm-level control variables lagged by one year. The definitions and construction of these variables are provided in Appendix Table 5-A1. The estimation includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The empirical analysis covers the period 2008–2018.

Dependent variable:	(1) Excess cash	(2) Insufficient cash (absolute value)
DiD (Treated × After)	-0.0055***	0.0024*
	(-5.3478)	(1.9906)
After	0.0032	-0.0041
	(0.8294)	(-1.0950)
Treated	0.0017	-0.0037
	(0.4878)	(-1.5095)
CF	0.0608**	0.0384***
	(2.6823)	(3.0032)
NWC	0.0849***	0.0519***
	(7.2729)	(5.4039)
Sales Growth	-0.0001	0.0000
	(-1.3920)	(0.8261)
Capex	-0.0435*	-0.0068
	(-1.7417)	(-0.4323)
Lev	0.0506***	-0.0069**
	(6.2421)	(-2.0976)
Age	0.0001	-0.0002
	(0.0627)	(-0.1086)
MA	-0.0545***	0.0255***
	(-5.9466)	(5.4968)
Observations	14,148	14,226
R-squared	0.3397	0.4030
Industry FE	Yes	Yes
Year FE	Yes	Yes
Stock exchange FE	Yes	Yes

Table 5-6 Robustness check – Falsification test

This table presents the results of a robustness analysis using a falsification (placebo) test based on the Difference-in-Differences (DiD) framework. The estimation follows the specification below:

$$ABCASH_{it} = \alpha + \beta_1.(Treated_i \times After_t) + \beta_2.Treated_i + \beta_3.After_t + \beta_4.X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

In this model, $ABCASH_{it}$ represents the dependent variable, defined as the absolute deviation between a firm's actual cash holdings and its estimated optimal level in year *t*. The coefficient β_1 on the interaction term *(Treated × After)* captures the estimated treatment effect during the placebo period. The variable $Treated_i$ is a dummy equal to one for firms subject to the U.K. carbon disclosure mandate and zero otherwise. $After_t$ *is a post-treatment indicator that takes the value of one for the post-false shock period (2006–2010) and zero for the pre-false shock period (2001–2005).* The vector X_{it-1} includes one-year-lagged firm-level control variables. The definitions of all variables are provided in Appendix Table 5-A1. The model also includes year (γ_t), industry **(**τ_j**)**, and stock exchange **(**λ_s**)** fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The empirical analysis covers the period 2001–2010.

Dependent variable: Abnormal cash holdings	(1)
DiD (Treated × After)	0.0012
	(0.4642)
Treated	-0.0018
	(-0.4467)
CF	0.0325
	(1.0153)
NWC	0.1296***
	(14.4173)
Sales Growth	0.0001
	(1.4686)
Capex	-0.0463**
	(-2.7226)
Lev	0.0334***
	(5.1981)
Age	-0.0018
	(-1.0367)
MA	-0.0253
	(-1.6770)
Observations	11,368
R-squared	0.2955
Industry FE	Yes
Year FE	Yes
Stock exchange FE	Yes

Note: The variable *After* is omitted from the regression because it is collinear with the included year fixed effects.

Table 5-7 Robustness check - Random treatment and control groups

This table presents the results of a robustness test based on a randomised treatment assignment. This analysis aims to confirm that the main Difference-in-Differences (DiD) results are not driven by random correlations or sample selection bias. The estimation follows the standard DiD model:

$$ABCASH_{it} = \alpha + \beta_1.(Treated_i \times After_t) + \beta_2.Treated_i + \beta_3.After_t + \beta_4.X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

In this specification, $ABCASH_{it}$ is the dependent variable, defined as the absolute deviation between a firm's actual cash holdings and its predicted (optimal) cash level in year *t. The variable $Treated_i$ is a randomly assigned dummy that equals one for firms designated to a placebo treatment group and zero otherwise.* To ensure robustness and eliminate the influence of random chance, the random assignment is repeated five times, with each iteration reported in Models (1) to (5) of the table. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes a one-year lag of firm-level control variables. Definitions of all variables are detailed in Table 5-A1. The model also includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The empirical analysis covers the period 2008–2018.

Dependent variable: Abnormal cash holdings	Random Treated (1)	Random Treated (2)	Random Treated (3)	Random Treated (4)	Random Treated (5)
DiD (Treated × After)	0.0007	0.0020	-0.0010	0.0011	0.0009
	(0.3802)	(1.1017)	(-0.6031)	(0.5408)	(0.4883)
Treated_fake1	0.0014				
	(1.2786)				
Treated_fake2		-0.0019*			
		(-1.7305)			
Treated_fake3			0.0029**		
			(2.5296)		
Treated_fake4				-0.0015	
				(-0.9205)	
Treated_fake5					0.0015
					(1.1210)
After	-0.0026	-0.0031	-0.0020	-0.0026	-0.0026
	(-1.0559)	(-1.1435)	(-0.7407)	(-0.9592)	(-0.9727)
CF	0.0992***	0.0991***	0.0989***	0.0991***	0.0996***
	(5.4028)	(5.4027)	(5.4029)	(5.3808)	(5.3999)
NWC	0.1370***	0.1370***	0.1369***	0.1370***	0.1370***
	(16.4258)	(16.3382)	(16.3261)	(16.4075)	(16.4091)
Sales Growth	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
	(-0.7989)	(-0.7871)	(-0.7889)	(-0.8066)	(-0.7914)
Capex	-0.0507**	-0.0510**	-0.0503**	-0.0507**	-0.0504**
	(-2.4855)	(-2.5129)	(-2.4733)	(-2.5021)	(-2.4754)
Lev	0.0438***	0.0438***	0.0437***	0.0438***	0.0439***
	(5.5869)	(5.5867)	(5.5594)	(5.5890)	(5.5762)
Age	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004
	(-0.2369)	(-0.2320)	(-0.2288)	(-0.2320)	(-0.2220)
MA	-0.0284***	-0.0284***	-0.0278***	-0.0283***	-0.0280***
	(-3.1186)	(-3.1137)	(-3.0449)	(-3.1065)	(-3.0744)

Dependent variable: Abnormal cash holdings	Random Treated (1)	Random Treated (2)	Random Treated (3)	Random Treated (4)	Random Treated (5)
Observations	14,148	14,148	14,148	14,148	14,148
R-squared	0.3232	0.3231	0.3233	0.3230	0.3232
Industry FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Stock exchange FE	Yes	Yes	Yes	Yes	Yes

Table 5-8 Robustness check – Omitted Variable bias

This table presents the results of a robustness analysis designed to address potential omitted variable bias in the Difference-in-Differences (DiD) estimation. The analysis follows the specification below:

$$ABCASH_{it} = \alpha + \beta_1.(Treated_i \times After_t) + \beta_2.Treated_i + \beta_3.After_t + \beta_4.X_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

In this specification, $ABCASH_{it}$ is the dependent variable, defined as the absolute deviation between a firm's actual cash holdings and its predicted (optimal) cash level in year *t*. The main coefficient of interest, β_1, captures the effect of mandatory carbon disclosure on abnormal cash holdings. The variable $Treated_i$ equals one for firms subject to the U.K. greenhouse gas (GHG) disclosure regulation and zero otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes a one-year lag of firm-level control variables. Core financial controls include cash flow (CF), net working capital (NWC), sales growth, capital expenditure (Capex), leverage (Lev), firm age (Age), and merger and acquisition activity (MA). To further address the risk of omitted variable bias, additional control variables are incorporated: dividend payer status (Div), market-to-book ratio (MTB), research and development expenditure (RD), debt issuance (DI), and equity issuance (EI). Definitions of all variables are detailed in Table 5-A1. The model also includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The empirical analysis covers the period 2008–2018.

Dependent variable: Abnormal cash holdings	(1)
DiD (Treated × After)	-0.0030***
	(-2.8197)
After	-0.0014
	(-0.5659)
Treated	-0.0031
	(-0.9395)
CF	0.0587***
	(2.9490)
NWC	0.1375***
	(16.7054)
Sales Growth	-0.0000
	(-0.4976)
Capex	-0.0452**
	(-2.2235)
Lev	0.0472***
	(5.5996)
Age	-0.0007
	(-0.3663)
MA	-0.0147
	(-1.4581)
MTB	0.0027**
	(2.5444)

Dependent variable: Abnormal cash holdings	(1)
Div	0.0043**
	(2.4176)
RD exp	0.0498
	(1.6042)
Debt Issuance	-0.0211***
	(-3.7998)
Equity Issuance	-0.0115
	(-0.6695)
Observations	14,148
R-squared	0.3260
Industry FE	Yes
Year FE	Yes
Stock exchange FE	Yes

Table 5-9 Robustness check – Adjusted fixed-effects

This table presents the results of a robustness test that employs adjusted fixed effects within the Difference-in-Differences (DiD) framework to further ensure the validity of the main findings. The analysis is based on the following specification:

$$ABCASH_{it} = \alpha + \beta_1.(Treated_i \times After_t) + \beta_2.Treated_i + \beta_3.After_t + \beta_4.X_{it-1} + \phi_i + \eta_{nt} + \theta_{nt} + \varepsilon_{it}$$

In this specification, $ABCASH_{it}$ is the dependent variable, defined as the absolute deviation between a firm's actual cash holdings and its predicted (optimal) cash level in year *t*. The main coefficient of interest, β_1, captures the effect of mandatory carbon disclosure on abnormal cash holdings. The variable $Treated_i$ equals one for firms subject to the U.K. greenhouse gas (GHG) disclosure regulation and zero otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes a one-year lag of firm-level control variables. Definitions of all variables are detailed in Table 5-A1. The model introduces an enhanced fixed-effects structure to control for unobserved heterogeneity at multiple levels. *Specifically,* ϕ_i *captures firm-level fixed effects,* η_{nt} *represents stock exchange–year effects, and* θ_{nt} *accounts for industry–year effects.* All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The empirical analysis covers the period 2008–2018.

Dependent variable: Abnormal cash holdings	(1)	(2)	(3)
DiD (Treated × After)	-0.0025**	-0.0056***	-0.0037**
	(-2.5127)	(-4.6134)	(-2.0522)
Treated		0.0024	-0.0017
		(0.9703)	(-0.5160)
After	-0.0009	-0.0005	-0.0017
	(-0.3530)	(-0.1577)	(-0.3761)
CF	0.0737***	0.0961***	0.1072***
	(4.5994)	(5.6054)	(5.3336)
NWC	0.0895***	0.1399***	0.1420***
	(10.8507)	(17.9868)	(15.7392)
Sales Growth	-0.0000	-0.0000	-0.0000
	(-0.9574)	(-1.0750)	(-0.0114)
Capex	-0.0488***	-0.0508**	-0.0541**
	(-2.8665)	(-2.5658)	(-2.4889)
Lev	0.0316***	0.0466***	0.0474***
	(5.2827)	(5.7704)	(4.9685)
Age	-0.0123**	-0.0001	-0.0004
	(-2.1832)	(-0.0667)	(-0.1955)
MA	-0.0148**	-0.0262**	-0.0305**
	(-2.4822)	(-2.4852)	(-2.1020)
Observations	14,141	14,088	13,403
R-squared	0.6368	0.3406	0.3762
Firm FE	Yes	No	No
Stock exchange-year FE	No	Yes	No
Industry-year FE	No	No	Yes

Table 5-10 Mandatory Carbon Disclosure and Abnormal Cash Holdings: Industry

This table presents the results of a Difference-in-Difference-in-Differences (DiDiD) analysis that examines how the effect of mandatory carbon disclosure on firms' abnormal cash holdings varies across industries with different levels of carbon intensity. The model is estimated using the following specification:

$Y_{it} = \alpha + \beta_1.\ (Treated_i \times After_t \times Industry_{it}) + \beta_2.(Treated_i \times After_t) + \beta_3.Treated_i + \beta_4.After_t + \beta_5\ .\boldsymbol{X}_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$

In this model, Y_{it} represents the dependent variable, which serves as a proxy for abnormal cash holdings, excess cash holdings, and insufficient cash holdings for firm i in year t. The key coefficient of interest, β_1, captures the triple interaction between $(Treated_i \times After_t \times Industry_{it})$. The variable $Industry_{it}$ is a binary indicator equal to one if a firm's carbon intensity is above the median, and zero otherwise. $Treated_i$ is a dummy variable equal to one for firms subject to the U.K. mandatory GHG disclosure regulation, and zero otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes a one-year lag of firm-level control variables. Definitions of all variables are detailed in Table 5-A1. The regression also includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The empirical analysis covers the period 2008–2018.

Dependent variables	ABCASH	(2) Excess cash	(3) Insufficient cash (absolute)
DiDiD (*Treated* × *After* × *Industry*)	-0.0048***	-0.0033***	0.0053**
	(-6.6757)	(-3.9632)	(2.0303)
DiD	-0.0020*	-0.0050***	0.0018
	(-1.9938)	(-5.5267)	(1.4370)
After	-0.0009	0.0033	-0.0041
	(-0.3668)	(0.8660)	(-1.0950)
CF	0.0736***	0.0125	0.0385***
	(4.6109)	(0.7382)	(3.0121)
NWC	0.0894***	0.0966***	0.0519***
	(10.8589)	(11.4453)	(5.4031)
Sales Growth	-0.0000	-0.0000	0.0000
	(-0.9693)	(-1.1613)	(0.8252)
Capex	-0.0490***	-0.0385	-0.0069
	(-2.8627)	(-1.6190)	(-0.4365)
Lev	0.0316***	0.0393***	-0.0069**
	(5.2976)	(7.3401)	(-2.0783)
Age	-0.0122**	-0.0049	-0.0002
	(-2.1330)	(-0.7970)	(-0.1081)
MA	-0.0146**	-0.0341***	0.0256***
	(-2.4559)	(-6.4474)	(5.5226)
Observations	14,141	14,141	14,226
R-squared	0.6368	0.7062	0.4031
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Table 5-11 Mandatory Carbon Disclosure and Abnormal Cash Holdings: Institutional Ownership

This table reports the results of a DiDiD regression that examines whether the effect of mandatory carbon disclosure on firms' abnormal cash holdings varies according to the level of institutional ownership. The model is estimated using the following specification:

$$Y_{it} = \alpha + \beta_1. (Treated_i \times After_t \times IO_{it}) + \beta_2. (Treated_i \times After_t) + \beta_3. Treated_i + \beta_4. After_t + \beta_5 .\boldsymbol{X}_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$$

In this model, Y_{it} denotes the dependent variable, which serves as a proxy for abnormal cash holdings, including both excess and insufficient cash holdings for firm i in year t. IO_{it} present the actual level of institutional ownership. $Treated_i$ is a dummy variable equal to one for firms subject to the U.K. mandatory greenhouse gas (GHG) disclosure regulation and zero otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes firm-level control variables lagged by one year. The definitions of these variables are provided in Appendix Table 5-A1. The regression also includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The empirical analysis covers the period 2008–2018.

	Dependent variable; *Abnormal cash holdings* *(1)*	Dependent variable; *Excess cash holding* *(2)*	Dependent variable; *Insufficient cash holdings* *(3)*
DiDiD (*Treated × After × IO*)	-0.0002***	-0.0004***	0.0002***
	(-3.7105)	(-4.9471)	(3.7681)
DiD	0.0124***	0.0255***	-0.0131***
	(2.7568)	(3.9443)	(-3.2113)
After	-0.0017	0.0026	-0.0034
	(-0.6366)	(0.6270)	(-0.8660)
Treated	-0.0012	0.0016	-0.0028
	(-0.3632)	(0.5178)	(-1.1647)
CF	0.0900***	0.0519**	0.0371***
	(5.5650)	(2.6389)	(2.7207)
NWC	0.1359***	0.0824***	0.0534***
	(19.3579)	(7.7543)	(5.5927)
Sales Growth	-0.0000	-0.0001	0.0000
	(-0.8118)	(-1.3344)	(0.7657)
Capex	-0.0548**	-0.0506**	-0.0030
	(-2.7040)	(-2.2638)	(-0.1788)
Lev	0.0447***	0.0504***	-0.0059*
	(6.1559)	(6.6228)	(-1.6920)
Age	-0.0010	-0.0003	-0.0002
	(-0.5030)	(-0.1438)	(-0.1495)
MA	-0.0287***	-0.0571***	0.0279***
	(-3.4482)	(-6.6564)	(5.8875)
Observations	13,255	13,255	13,323
R-squared	0.3278	0.3518	0.4116
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Stock exchange FE	Yes	Yes	Yes

Table 5-12 Mandatory Carbon Disclosure and Abnormal Cash Holdings: investment horizon

This table presents the results of a DiDiD regression that examines whether the impact of mandatory carbon disclosure on firms' abnormal cash holdings differs according to the investment horizon of institutional investors**.** The estimation follows the model specification below:

$Y_{it} = \alpha + \beta_1 . (Treated_i \times After_t \times Type_{it}) + \beta_2 . (Treated_i \times After_t) + \beta_3 . Treated_i + \beta_4 . After_t + \beta_5 . \boldsymbol{X}_{it-1} + \gamma_t + \tau_j + \lambda_s + \varepsilon_{it}$

In this model, Y_{it} represents the dependent variable, which serves as a proxy for abnormal cash holdings, including both excess and insufficient cash holdings, for firm *i* in year *t*. The main coefficient of interest, β_1, measures the triple interaction among $Treated_i$, $After_t$, and $Type_{it}$, capturing how the regulatory effect of carbon disclosure varies with investors' investment horizons. The variable $Type_{it}$ denotes a proxy for the type of institutional ownership, the proportion of firm ownership held by long-term or short-term institutional investors. The variable $Treated_i$ equals one for firms subject to the U.K. mandatory GHG disclosure regulation, and zero otherwise. $After_t$ indicates the compliance period: it equals one from 2013 for firms with fiscal years ending on or after September 30, and from 2014 for firms with fiscal years ending before September 30, following Jouvenot & Krueger, 2019. The vector X_{it-1} includes firm-level control variables lagged by one year. The definitions are provided in Appendix Table 5-A1. The regression also includes year (γ_t), industry (τ_j), and stock exchange (λ_s) fixed effects. All continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are clustered at the stock exchange level. Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The empirical analysis covers the period 2008–2018.

Dependent variable: *Abnormal cash holdings*	Long-term institutional ownership	Short-term institutional ownership
	(1)	(2)
DiDiD (Treated × After × Type)	-0.0002***	0.0014***
	(-4.0516)	(4.1918)
DiD	0.0145***	-0.0036*
	(3.1118)	(-1.8340)
After	-0.0017	-0.0027
	(-0.6492)	(-0.8319)
Treated	-0.0012	-0.0036
	(-0.3746)	(-0.9625)
CF	0.0903***	0.0692***
	(5.5791)	(4.0482)
NWC	0.1358***	0.1255***
	(19.3418)	(9.8270)
Sales Growth	-0.0000	-0.0000
	(-0.8113)	(-0.1268)
Capex	-0.0548**	-0.0279
	(-2.7039)	(-0.7714)
Lev	0.0448***	0.0552***
	(6.1618)	(5.6430)
Age	-0.0009	-0.0010
	(-0.4941)	(-0.5143)
MA	-0.0290***	-0.0304***
	(-3.4962)	(-4.9733)
Observations	13,247	6,619

Dependent variable: *Abnormal cash holdings*	Long-term institutional ownership	Short-term institutional ownership
	(1)	(2)
R-squared	0.3279	0.3884
Industry FE	Yes	Yes
Year FE	Yes	Yes
Stock exchange FE	Yes	Yes

Appendix to Chapter 5

Table 5-A1: Variable Definition

Variable	Description	Data source
Dependent variables: Main measures		
ABCASH	The absolute abnormal cash holdings are calculated as the absolute difference between a firm's actual cash ratio and its estimated target (optimal) cash ratio.	Constructed
Excess cash	The positive difference between the *actual cash ratio* and the *predicted (optimal) cash ratio*. Negative values are replaced with zero so that only positive values (or zero) remain. This variable measures the extent to which a firm holds cash reserves above its optimal level, indicating potential overfunding. (Oler & Picconi, 2014)	Constructed
Insufficient cash (absolute)	The absolute value of the negative difference between the actual cash ratio and the predicted (optimal) cash ratio. Excess cash observations are set to zero so that only positive values (or zero) remain. This variable measures the extent to which a firm's cash holdings fall below the optimal level, capturing potential liquidity constraints or underfunding. (Oler & Picconi, 2014)	Constructed
Cash	The cash ratio is calculated as cash and short-term investments divided by total assets. This ratio represents the proportion of liquid assets held by a firm and serves as the basis for estimating abnormal cash holdings.	Derived from S&P Capital IQ
Key DiD variables		
Treated	A treatment indicator equal to one for firms subject to the U.K. Mandatory Carbon Disclosure Regulation (The Companies Act 2006 – Strategic Report and Directors' Report Regulations 2013) and zero otherwise.	Derived from the London Stock Exchange website
After	A post-treatment indicator that captures the period in which the regulation became effective. It takes the value of one from 2013 for firms with fiscal years ending on or after 30 September, and one from 2014 for firms with earlier fiscal year ends, consistent with the compliance timeline of the U.K. GHG disclosure mandate (Jouvenot & Krueger, 2019).	Derived from S&P Capital IQ
IO	The percentage of shares held by institutional investors in firm i during year t.	Derived from S&P Capital IQ
Type	The ownership structure of institutional investors is measured as the proportion of shares held by long-term or short-term institutional investors.	Derived from S&P Capital IQ
Industry	A binary indicator equal to one if a firm operates in a high carbon-emission (GHG-intensive) industry, and zero otherwise. Industry classification is based on firms' sectoral carbon intensity relative to the sample median, distinguishing high-emission sectors from less carbon-intensive industries.	Derived from S&P Capital IQ

Variable	Description	Data source
Control variables		
CF	Calculated as operating income minus interest and taxes, divided by total assets.	Derived from S&P Capital IQ
NWC	Defined as current assets minus current liabilities minus cash, scaled by total assets.	Derived from S&P Capital IQ
Capex	The ratio of capital expenditures to total assets indicates the extent of a firm's investment in long-term productive assets.	Derived from S&P Capital IQ
Lev	Calculated as total debt divided by total assets.	Derived from S&P Capital IQ
Sales Growth	The annual percentage change in net sales is calculated as (current year net sales − prior year net sales) / prior year net sales.	Derived from S&P Capital IQ
MA	The ratio of cash paid for mergers and acquisitions to total assets.	Derived from S&P Capital IQ
Age	The natural logarithm of the number of years since the firm's incorporation or listing.	Derived from S&P Capital IQ
Additional control variables		
MTB	The ratio of the market value of equity to total assets.	Derived from S&P Capital IQ
RD	The ratio of research and development (R&D) expenses to total assets.	Derived from S&P Capital IQ
Div	The ratio of common dividends paid to total assets.	Derived from S&P Capital IQ
Debt Issuance	The amount of new debt issued during the year is scaled by total assets.	Derived from S&P Capital IQ
Equity Issuance	The amount of new equity issued during the year is scaled by total assets.	Derived from S&P Capital IQ

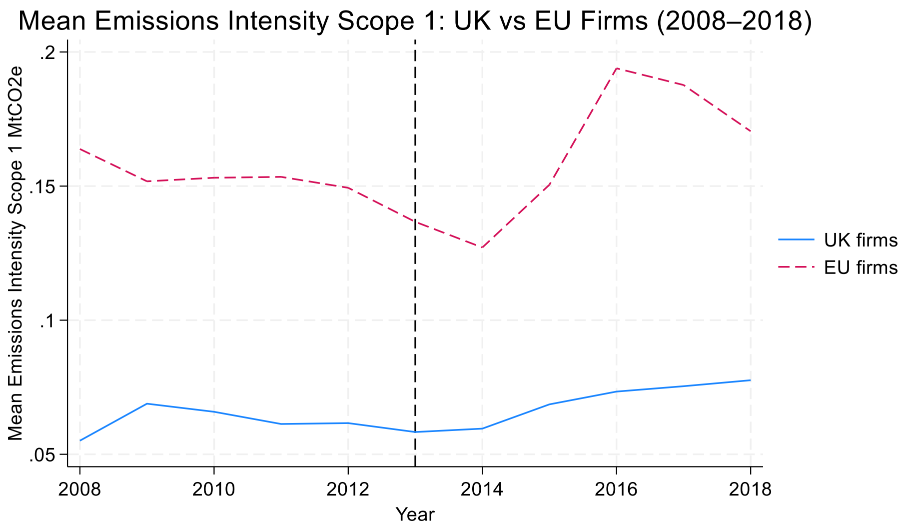
Table 5-A2 Parallel trend assumption

This table presents the results of the event-study regression used to test the parallel trend assumption underlying the Difference-in-Differences (DiD) design. The analysis examines the dynamic effects of *The Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013* on firms' abnormal cash holdings during the four years preceding and following the introduction of the regulation. The dependent variable, *abnormal cash holdings*, is defined as the absolute deviation between a firm's actual cash holdings and its predicted optimal cash level in each year. The variable *Treated* is a binary indicator that equals one for firms subject to the U.K. GHG disclosure regulation and zero otherwise. *Year = t* represents year-specific dummy variables, while the interaction terms Treated × Year = t measure the difference in abnormal cash holdings between treated and control firms for each year relative to the baseline. The coefficients on the interaction terms capture changes in abnormal cash holdings over time, allowing the estimation of pre- and post-regulation trends**.** Reported t-statistics are shown in parentheses. Statistical significance is indicated by *, **, and ***, representing the 10%, 5%, and 1% levels, respectively. The empirical analysis covers the period 2008–2018.

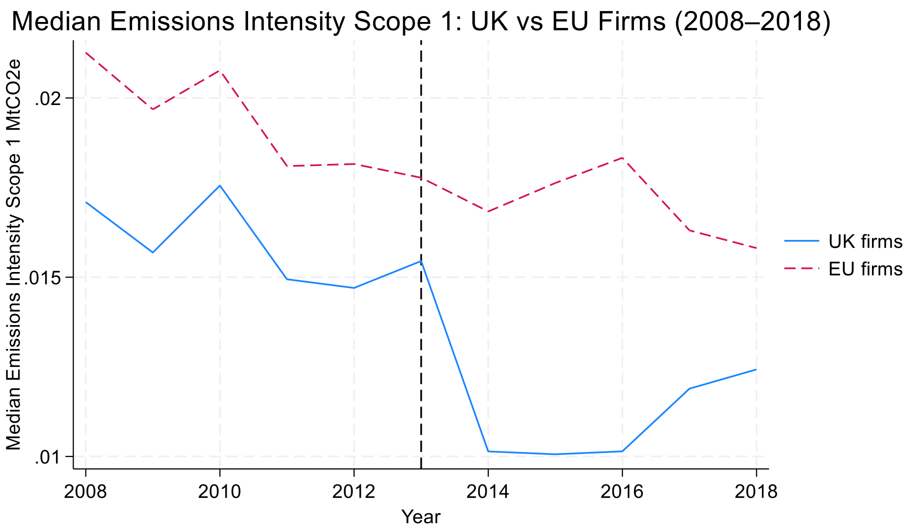
	(1)
Treated × Year = 2009	0.0092***
	(3.8346)
Treated × Year = 2009	-0.0013
	(-0.5313)
Treated × Year = 2010	-0.0037
	(-1.4104)
Treated × Year = 2011	-0.0017
	(-0.6964)
Treated × Year = 2012	0.0000
	(.)
Treated × Year = 2013	0.0022
	(0.8741)
Treated × Year = 2014	0.0023
	(0.8724)
Treated × Year = 2015	0.0019
	(0.7713)
Treated × Year = 2016	0.0006
	(0.1964)
Treated × Year = 2017	-0.0016
	(-0.5645)
Treated × After	-0.0067**
	(-2.5771)
Controls	Yes
FE	Yes
Observations	14,237
R-squared	0.2993

Figure 5-A1. Distribution of GHG emissions intensity

This figure reports the annual mean (Panel A) and median (Panel B) of Scope 1 greenhouse gas (GHG) emissions intensity for the sample firms from 2008 to 2018. Emissions intensity is measured as Scope 1 GHG emissions scaled by firm size (as defined in Appendix A) and is used to describe the time-series variation in firms' carbon exposure. Panel A presents the annual mean emissions intensity, while Panel B presents the annual median emissions intensity.



Panel A. Mean of emissions intensity scope 1



Panel B. Median of emissions intensity scope 1

Figure 5-A1 presents the annual mean (Panel A) and median (Panel B) Scope 1 GHG emissions intensity for U.K. (treated) and EU (control) firms over the period 2008–2018. Emissions intensity is measured as Scope 1 emissions scaled by firm size, as defined in Appendix A. The vertical line marks the introduction of the U.K. mandatory carbon disclosure regulation in 2013.

Prior to the regulation, the trends in emissions intensity for U.K. and EU firms are broadly comparable. Both the mean and median series evolve in a similar and relatively parallel manner, indicating no systematic divergence between treated and control firms before the policy change. This pattern supports the assumption that, in the absence of the regulation, the two groups would likely have continued to follow similar environmental performance trends. Although there is a slight increase in emissions intensity for treated firms around 2012 (particularly visible in the median), this does not represent a sustained deviation and may reflect improved measurement and reporting practices in anticipation of the forthcoming disclosure requirement.

After 2013, a noticeable decline in emissions intensity emerges among U.K. firms relative to EU firms. The reduction is more pronounced in the median (Panel B) than in the mean (Panel A), suggesting that the adjustment is not driven solely by a small number of high-emission outliers. Instead, the sharper decline in the median indicates that the typical treated firm reduces its emissions intensity following the introduction of mandatory disclosure. While the mean also declines, its smoother pattern suggests that some high-emission firms may adjust more gradually.

Chapter 6: Discussion and Conclusion

This thesis explores how mandatory carbon disclosure shapes institutional capital allocation and corporate financial decision-making. This thesis is motivated by the growing academic and policy interest in understanding the financial consequences of environmental regulation (e.g., Atta-Darkua et al., 2023; Cao et al., 2023; Ilhan et al., 2019; Jouvenot & Krueger, 2019; Krueger et al., 2021; Marshall et al., 2022). To answer this question, by leveraging a quasi-natural experiment in the U.K., the three empirical studies provide causal evidence on the financial market consequences of climate regulation. This thesis contributes to the emerging body of work at the intersection of sustainable finance, corporate governance, and policy-driven financial behaviour. The first empirical chapter (Chapter 3) examines how institutional investors with varying investment horizons, monitoring roles, and sustainability orientations adjust their capital allocation towards reduced-emission firms after the disclosure regulation. The second empirical chapter (Chapter 4) examines how firms modify their dividend payout policies in response to increased transparency and investor scrutiny after the disclosure regulation. The third empirical chapter (Chapter 5) analyses the effect of mandatory disclosure on corporate cash holdings.

6.1 Summary of key findings and contributions

The findings show that mandatory carbon disclosure significantly affects corporate financial behaviour by shaping institutional investment, governance, and internal financial policies. First, it influences ***capital allocation*** by encouraging long-term, independent institutional investors and those who are PRI signatories or based in environmentally conscious countries to increase their holdings in firms with lower carbon emissions. This suggests that environmental transparency serves as a reliable signal of reduced risk and long-term value.

Second, it enhances ***governance discipline***, as evidenced by a 10.53% rise in dividend payouts following disclosure mandates, particularly among firms with high institutional ownership and strong environmental performance. This indicates that transparency lowers agency costs and strengthens investor oversight, prompting firms to distribute excess cash rather than retain it unnecessarily. Third, it reflects ***financial policy responses***; firms respond to disclosure by reducing abnormal cash holdings, especially those with high emissions and substantial institutional ownership. This reflects improved governance and more efficient use of financial resources under increased scrutiny. Collectively, these findings show that mandatory carbon disclosure not only promotes sustainable investment but also drives better corporate financial practices through enhanced transparency and accountability. The summarising of each empirical chapter is as follows.

6.1.1 Carbon intensity and heterogeneity of institutional ownership

In the first empirical chapter, I examine how firms with lower carbon emission following the introduction of mandatory disclosure affect the behaviour of institutional investors, and how this effect varies across different types of investors with distinct preferences. I use the U.K. mandatory carbon disclosure as a quasi-natural experiment to identify the effect of disclosure on investor heterogeneity. The policy requires listed firms to report their carbon emissions in a uniform and mandatory format. This uniform reporting system ensures that all firms disclose comparable information, reducing inconsistencies and improving transparency. Such a setting is important because capital markets generally rely on disclosures that share three key characteristics: they are mandatory, standardised, and submitted through regulated documents. These features enhance the credibility, consistency, and usefulness of information for investors, allowing them to make better-informed decisions and improve overall market efficiency. By contrast, other forms of environmental and social reporting have often lacked one or more of these features. The U.K. regulation helps close this gap by requiring firms to disclose information in a standardised and compulsory format within regulated documents. This policy provides a suitable context to examine whether and how investors with different investment horizons and strategies adjust their holdings when firms' carbon performance becomes more transparent (Jouvenot & Krueger, 2019).

By employing a quasi-natural experiment created by the U.K.'s mandatory carbon disclosure regulation and using a difference-in-differences (DiD), I examine how firm-level carbon emissions influence institutional investor ownership. I focus on firms that already voluntarily disclose their GHG emissions prior to the U.K. regulation, following the study of Jouvenot & Krueger (2019). Consistent with the carbon emissions reduction attraction hypothesis, the results indicate that institutional investors significantly increase their ownership in firms that actively lower their emissions following the implementation of the mandatory disclosure policy. The economic magnitude of this effect ranges from 4.27% to 19.24% increases in institutional ownership for firms that lower emissions, supporting the view that environmental transparency and carbon performance are value-relevant signals for investors (Jouvenot & Krueger, 2019; Krueger et al., 2020).

I further document deeper and find that not all categories of institutional investors respond to carbon emission firms similarly. In line with the literature on investor heterogeneity (Marshall et al., 2022; Starks et al., 2017), the results show that long-term institutional investors, such as pension funds, exhibit a stronger preference for firms that engage in carbon emissions reduction compared to short-term investors like hedge funds. This finding supports the hypothesis that long-term investors are motivated by sustainability considerations that align with long-horizon return objectives and risk mitigation through climate-conscious investment practices (Albuquerque et al., 2019; Starks et al., 2017). Additionally, I also find that independent institutional investors, characterised by active monitoring and lower information asymmetry costs, significantly increase their ownership in firms, reducing carbon emissions relative to grey investors, who often have business ties with investee firms (Aggarwal et al., 2011; Chen et al., 2007). This finding aligns with theories suggesting that independent investors value sustainability disclosures and environmental transparency, viewing them as credible signals of corporate governance and risk management (Chan et al., 2014; Dhaliwal et al., 2011). Furthermore, I find that institutional investors who are signatories to the Principles for Responsible Investment (PRI) are more likely to allocate capital to firms with lower carbon emissions, supporting the hypothesis that responsible investors actively align their portfolios with environmental objectives (Brandon et al., 2022; Dyck et al., 2019). This evidence is consistent with prior studies showing that PRI signatories exert significant influence on firms' environmental and social outcomes and prioritise carbon reduction in their investment decisions (Benlemlih et al., 2023; Grewal, 2017).

Finally, I provide evidence that institutional investors domiciled in countries with strong environmental social norms show a greater propensity to invest in firms with lower carbon emissions. Using the Environmental Performance Index (EPI) to measure social norms, I find that investors from high EPI countries allocate more capital to low-carbon firms, reflecting the integration of societal environmental values into financial decision-making (Dyck et al., 2019; Hong & Kacperczyk, 2009). Through these findings, I contribute to the ESG and climate finance literature by providing causal evidence that firms' carbon emissions reduction attracts institutional capital and that investor heterogeneity significantly shapes the allocation of capital in response to environmental performance.

In summary, this empirical study contributes to the sustainable finance and ESG investment literature by providing the first causal evidence on how firm-level carbon emissions reductions influence institutional investors' capital allocation decisions, using a robust quasi-natural experiment from the U.K.'s mandatory carbon disclosure regulation. By employing a

Difference-in-Differences (DiD) approach, this study mitigates endogeneity concerns that have posed challenges to prior research in this field (Bolton & Kacperczyk, 2021a; Jouvenot & Krueger, 2019). I demonstrate that institutional investors significantly increase their holdings in firms that actively lower their carbon emissions, indicating that environmental transparency and carbon performance serve as credible signals for investors concerned with long-term risks (Krueger et al., 2020). This finding not only confirms the economic relevance of environmental disclosures but also provides new insights into how regulatory interventions can shape capital flows in global markets, emphasising the role of policy in driving firm-level sustainability and financial market development.

Beyond establishing the attractiveness of low-emissions firms to institutional investors, I advance the literature by documenting the heterogeneity in investor responses to firms' carbon reduction efforts. I show that long-term investors, independent investors, PRI signatories, and investors from countries with strong environmental social norms exhibit a stronger preference for firms that improve their carbon performance. These findings reveal that investors' investment horizons, monitoring roles, responsible investment commitments, and home-country social norms critically shape their sustainable investment behaviour, aligning with theories of heterogeneous ESG preferences among institutional investors (Brandon et al., 2022; Dyck et al., 2019). By unpacking these nuanced differences, I offer a comprehensive understanding of how different institutional investor types integrate climate-related considerations into their investment decisions, providing actionable insights for policymakers aiming to enhance the effectiveness of environmental regulations in mobilising sustainable finance.

6.1.2 Mandatory carbon disclosure and dividend policy.

In Chapter 4, I examine how mandatory carbon disclosure affects firms' dividend payout policies. I utilise a difference-in-differences (DiD) estimation strategy to identify the causal impact of mandated, standardised greenhouse gas (GHG) emissions disclosure on firms' dividend payouts. Prior studies indicate that mandatory environmental disclosure (ESG/CSR) can enhance comparability across firms and reduce information asymmetry (Downar et al., 2021; Jouvenot & Krueger, 2019), yet its influence on corporate payout policy remains underexplored. I contribute to this emerging literature by focusing on the U.K.'s mandatory carbon disclosure regulation under the Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013 to test whether transparency and regulatory pressure drive changes in corporate financial behaviour, specifically dividend policy.

I find that mandatory carbon disclosure leads to a significant increase in firms' dividend payout ratios, with treated firms increasing dividends by approximately 10.53% compared to the average firm following the implementation of the regulation. This finding aligns with the hypothesis that improved disclosure reduces agency conflicts and information asymmetry, enabling enhanced monitoring by investors, which in turn constrains managerial discretion over free cash flows and incentivises firms to increase dividends (Fonseka & Richardson, 2023; Grewal et al., 2019; Hail et al., 2014). My results remain robust across various alternative dividend measures, placebo DiD tests, and additional controls, supporting the view that the mandatory carbon disclosure regulation causally affects dividend policy (Jouvenot & Krueger, 2019).

Furthermore, I find that the positive dividend response is stronger for firms with higher institutional ownership, particularly those with greater long-term institutional ownership and lower carbon emissions. These findings are consistent with the literature suggesting that institutional investors, particularly long-term and actively monitoring institutions, integrate environmental and social criteria into their investment mandates and push firms toward sustainability while maintaining capital discipline (Dyck et al., 2019; Marshall et al., 2022). My results indicate that firms with higher institutional ownership face greater pressure to distribute cash to shareholders following enhanced transparency requirements, while firms with lower carbon emissions, which may have already demonstrated a commitment to environmental practices, signal their financial health through higher payouts (Benlemlih et al., 2023; Grewal et al., 2019). Additionally, I contribute to the literature by demonstrating that mandatory, standardised carbon disclosure regulations can shape corporate payout behaviour differently than voluntary disclosures, as the regulatory environment creates implicit liabilities, increases reputational costs, and enhances investor monitoring, leading to significant financial policy adjustments (Christensen et al., 2018; Fonseka & Richardson, 2023; Healy & Palepu, 2001). My findings align with the broader evidence that disclosure mandates enhance firms' environmental activities while maintaining financial discipline (Christensen et al., 2018).

Through this study, I contribute to three strands of the literature. First, I add to the research on the economic consequences of mandatory non-financial disclosures on corporate financial decisions, expanding the discussion beyond liquidity and valuation to dividend policy (e.g. Baboukardos, 2017; Bolton & Kacperczyk, 2021b). Second, I advance the mandatory carbon disclosure literature by providing the first causal evidence linking such regulations to firms' payout decisions using a robust identification strategy within a European multi-country setting (Jouvenot & Krueger, 2019; Krueger et al., 2021). Third, I demonstrate that institutional ownership and firms' carbon emissions levels are key channels through which regulatory interventions shape financial decisions, providing actionable insights for policymakers aiming to align environmental objectives with financial market development (Dyck et al., 2019; Gibbons, 2020). Overall, I show that mandatory carbon disclosure increases dividend payouts, reflecting firms' adaptation to increased transparency and monitoring pressures while signalling commitment to shareholder value. This evidence highlights how environmental regulations can drive both sustainability and financial market outcomes, emphasising the role of policy in shaping corporate behaviour in the context of climate transition.

6.1.3 Mandatory carbon disclosure and abnormal cash holdings

In Chapter 5, I examine how mandatory carbon disclosure influences firms' abnormal cash holdings by using the introduction of a unique regulation in the U.K. as a quasi-natural experiment. Specifically, I exploit the Companies Act 2006 (Strategic Report and Directors' Report) Regulations 2013, which require firms to disclose their greenhouse gas (GHG) emissions in a mandatory, standardised, and prescriptive format. This regulation serves as an exogenous intervention that allows me to examine how environmental disclosure mandates affect firms' deviations from their optimal cash levels. Prior studies suggest that, unlike financial disclosures, which are typically mandatory, standardised, and regulated, environmental disclosures often lack these characteristics (Jouvenot & Krueger, 2019). The introduction of this law, therefore, provides an ideal setting to assess how the enforcement of such disclosure requirements influences firms' financial policies. By focusing on abnormal cash holdings, a measure that captures both excess and insufficient cash relative to estimated optimal levels, this chapter offers new insights into how firms adjust their liquidity management in response to environmental disclosure regulation. The findings contribute to a better understanding of the interaction between sustainability reporting and corporate financial decisions, highlighting the broader economic implications of mandatory environmental disclosure policies.

By employing a difference-in-differences (DiD) approach using a sample of U.K.-listed firms as the treatment group and European firms as the control group, I find that mandatory carbon disclosure leads to a statistically significant reduction in abnormal cash holdings by approximately 4.66% relative to the control group post-regulation. This finding supports the view that environmental transparency and increased stakeholder monitoring under mandatory disclosure frameworks improve financial discipline within firms by aligning managerial cash management practices with shareholder interests, thereby addressing agency conflicts (Dittmar & Mahrt-Smith, 2007; Harford et al., 2008; Jensen, 1986). Additionally, I decompose abnormal cash holdings into excess cash and insufficient cash components and find that excess cash holdings significantly decrease by approximately 20.83% following the regulation, while absolute insufficient cash levels increase moderately. This suggests that firms are not merely reducing cash arbitrarily but are actively moving toward optimal cash management, consistent with the argument that enhanced transparency reduces managerial incentives to hoard excess cash for non-value-maximising purposes (Azar et al., 2021; Chithambo et al., 2020). My results remain robust across various model specifications, alternative measures, and placebo DiD tests, confirming the validity of my identification strategy and supporting the parallel trend assumption. Furthermore, I explore heterogeneity across institutional ownership and carbon emissions levels and find that the reduction in abnormal cash holdings is more pronounced among firms with higher institutional ownership and higher carbon emissions. This finding aligns with prior studies suggesting that institutional investors, particularly long-term, exert pressure on firms to adopt more disciplined financial policies when environmental transparency improves (Dyck et al., 2019; Marshall et al., 2022). It also indicates that high-emission firms, which are more exposed to reputational and regulatory risks, respond to mandatory carbon disclosure by improving cash efficiency to mitigate these pressures (Amin et al., 2024; Chen et al., 2024).

Through these findings, I contribute to the literature in three key ways. First, I extend the literature on the exogenous determinants of corporate financial policies by showing that environmental disclosure mandates causally reduce abnormal cash holdings, expanding prior research linking legal and regulatory frameworks to firms' liquidity management practices (Chang et al., 2024; Jadiyappa et al., 2021). Second, I add to the environmental disclosure literature by providing evidence that mandatory, standardised carbon disclosure can systematically and predictably influence financial discipline, differentiating from the effects of voluntary disclosure regimes (Downar et al., 2021). Third, I contribute to the broader climate finance literature by demonstrating that mandatory carbon disclosure not only drives environmental transparency but also fosters improved corporate governance and resource allocation, emphasising that well-designed environmental policies can encourage firms to reduce uncertainties while enhancing their competitiveness (Bolton & Kacperczyk, 2021; Krueger, 2015). Overall, I demonstrate that mandatory carbon disclosure promotes better cash management practices by reducing excess liquidity and encouraging firms to align financial behaviour with long-term sustainability and shareholder interests. My findings highlight that environmental policy can simultaneously support climate objectives and enhance financial market discipline, providing actionable insights for regulators aiming to leverage disclosure frameworks to drive sustainability transitions in corporate practices.

6.1.4 Cross-chapter synthesis and integration

The three empirical chapters (Chapters 3, 4, and 5) of this thesis are conceptually interconnected through the unifying lens of agency theory, enriched by insights from signalling and stakeholder theories. In Chapter 3, mandatory carbon disclosure serves as an exogenous regulatory shock that reduces information asymmetry and aligns managerial incentives with stakeholder expectations, attracting greater institutional ownership, especially from long-term, high monitoring role and socially responsible investors (Cohen et al., 2023; Dyck et al., 2019; Krueger et al., 2020). Importantly, this shift is not merely a reaction to environmental performance but reflects deeper governance and transparency considerations. These investors then exert monitoring pressure on firms, influencing financial policy decisions observed in Chapters 4 and 5. Specifically, following the mandate, the rise in institutional ownership is associated with both higher dividend payouts (Chapter 4) and lower abnormal cash holdings (Chapter 5). This pattern aligns with agency theory predictions (Harford et al., 2008; Jensen, 1986). By improving transparency, carbon disclosure enables investors, especially long-term institutional shareholders, to detect agency problems more readily. As a result, managers may choose to return more cash to shareholders to avoid criticism for misallocating funds, particularly when environmental compliance limits investment opportunities.

Following this, a unifying mechanism across the three chapters is the role of transparency induced by mandatory disclosure in reducing agency costs and strengthening governance. Greater visibility allows stakeholders, especially institutional investors, to better assess risk, monitor management, and demand shareholder-aligned actions (Dhaliwal et al., 2012; Grewal et al., 2019). In line with this, Chapter 4 shows that transparency leads to higher dividends, signalling financial stability and responsible management (Baker & Wurgler, 2004; Nagar & Schoenfeld, 2021). Similarly, Chapter 5 demonstrates that the same governance pressure results in lower excess cash holdings, indicating reduced managerial discretion and improved capital efficiency (Opler et al., 1999; Pinkowitz et al., 2012). Moreover, these effects are strongest among firms with higher institutional ownership, illustrating that transparency, coupled with investor oversight, drives tangible changes in financial behaviour.

While agency theory serves as the primary explanatory framework, signalling and stakeholder theories provide complementary perspectives. Specifically, the dividend increases observed in Chapter 4, even in the face of potential sustainability investment demands, highlight dividends' signalling value as a reputational tool (Fonseka & Richardson, 2023). At the same time, stakeholder theory explains why firms respond not only to investor monitoring but also to broader societal expectations embedded in disclosure regulations (Ioannou & Serafeim, 2017). Finally, Chapter 3 shows that post-regulation increases in institutional ownership are concentrated among specific investor subgroups, underscoring that environmental integration is not uniform. Overall, these findings offer a coherent, multi-theoretical explanation of how disclosure shapes institutional investment and corporate financial policy.

6.2 Implication

This thesis offers important implications for four key stakeholders: policymakers, institutional investors, corporate managers, and researchers. Through a quasi-natural experiment using the U.K.'s 2013 mandatory carbon disclosure regulation, the findings demonstrate how standardised, prescriptive, and legally enforced disclosure requirements influence firm behaviour, capital allocation, and financial decision-making. The results suggest that mandatory environmental disclosure is not just a reporting tool, but a transformative policy mechanism capable of shaping both sustainability and financial outcomes.

The findings in Chapter 3 show that long-term institutional investors, especially those with sustainability mandates (such as PRI signatories) and those domiciled in countries with strong environmental norms, are more likely to increase their holdings in firms that reduce carbon emissions after mandatory disclosure takes effect. This supports the idea that carbon transparency serves as a credible signal of corporate responsibility and long-term risk management (Krueger et al., 2020). However, the evidence also reveals that institutional investors may pressure firms to increase dividend payouts and reduce excess cash holdings, which, while improving financial discipline, might limit firms' flexibility to invest in innovation or respond to future economic shocks. This highlights a key trade-off that investors must balance ESG preferences with long-term financial resilience. To enhance sustainable investing strategies, investors should integrate environmental metrics with traditional financial indicators, accounting for both value creation and risk mitigation (Ioannou & Serafeim, 2015).

For policymakers, this thesis provides strong evidence that mandatory carbon disclosure improves market efficiency by reducing information asymmetry, strengthening investor oversight, and encouraging better financial governance, such as disciplined cash management and higher dividend distributions (Christensen et al., 2018; Grewal et al., 2019). These outcomes align with policy goals of encouraging both environmental accountability and corporate transparency. Nonetheless, policymakers should be cautious of potential unintended consequences. Pressures to signal financial discipline may push firms toward short-term payouts at the expense of long-term investment, including R&D and innovation capacity (Benlemlih & Girerd-Potin, 2017). To address this, regulations should not only mandate disclosure but also allow flexibility for firms to contextualise their financial responses within broader sustainability strategies. Studies suggest that disclosures are most effective when embedded in financial filings, tied to performance metrics, and subject to third-party verification (Christensen et al., 2021; Jouvenot & Krueger, 2019). The findings of this thesis also closely align with current global developments in climate-related financial disclosure, such as the International Sustainability Standards Board's (ISSB) IFRS [22] standards and the

[22] The International Sustainability Standards Board's (ISSB) IFRS Sustainability Disclosure Standards are a set of global baseline rules for how companies should report sustainability-related information to investors and other capital market participants. See https://www.ifrs.org/groups/international-sustainability-standards-board/

European Union's Corporate Sustainability Reporting Directive (CSRD)[23]. Both initiatives emphasise mandatory, standardised, and assured disclosure of sustainability and climate-related information, principles mirrored in the U.K.'s 2013 carbon disclosure regulation examined in this research which adopted in 2021 and 2023 respectively. The evidence presented here shows that such high-quality, prescriptive disclosure frameworks can meaningfully influence investor behaviour, capital allocation, and corporate financial policy, thereby supporting the policy rationale behind these emerging global standards. By demonstrating that mandatory and comparable disclosures reduce information asymmetry, enhance market discipline, and incentivise governance improvements, this thesis provides empirical backing for the harmonisation and enforcement of climate-related reporting requirements across jurisdictions.

Moreover, the results highlight that well-designed disclosure regimes not only meet transparency objectives but also trigger substantive changes in corporate behaviour, underscoring the potential of ISSB and CSRD frameworks to drive both sustainability outcomes and capital market efficiency at an international scale. Specifically, research by Jouvenot and Krueger (2019) and Krueger et al. (2020) underscores that these characteristics reduce information asymmetry and allow market participants to distinguish between firms with genuine environmental commitments and those engaging in symbolic compliance. Standardisation ensures that disclosures are consistent and comparable across firms, which is critical for benchmarking and capital allocation (Christensen et al., 2021). Mandatory disclosure carries legal and reputational consequences, heightening firms' incentives to align

[23] The European Union's Corporate Sustainability Reporting Directive (CSRD) is a mandatory sustainability reporting framework that significantly expands and strengthens ESG disclosure requirements for companies operating in or connected to the EU. It was adopted in January 2023 and replaces the earlier Non-Financial Reporting Directive (NFRD). https://finance.ec.europa.eu/regulation-and-supervision/financial-services-legislation/implementing-and-delegated-acts/corporate-sustainability-reporting-directive_en

their actual practices with reported environmental performance (Grewal et al., 2019). Prescriptiveness eliminates ambiguity in what and how to report, curbing selective disclosure and greenwashing. This thesis highlights that credible, granular carbon disclosure frameworks not only influence investor behaviour but also induce internal organisational adjustments such as capital reallocation, improved governance, and revised financial policies to align with evolving market expectations and regulatory scrutiny.

For corporate managers, this research shows that credible carbon disclosures and emissions reductions can attract high-quality, long-term institutional capital, improve market credibility, and differentiate firms in ESG-focused investor segments. Enhanced transparency also strengthens internal governance by reducing excess cash reserves and aligning payout policies with investor expectations (Dhaliwal et al., 2011). However, managers should be mindful not to overreact to investor pressure. Excessive focus on dividend increases or cash reductions may reduce flexibility and resilience, especially in sectors facing transition risks. Managers should adopt a strategic approach to disclosure, using it as a platform to communicate long-term value creation, risk management, and climate transition plans not just as a compliance exercise (Flammer et al., 2021).

For researchers, this thesis contributes to the growing literature on sustainable finance and the economic consequences of environmental regulation. It provides causal evidence that mandatory carbon disclosure influences both investor behaviour and firm financial policy, highlighting disclosure as a key driver of capital allocation and governance change. Importantly, the findings underscore the heterogeneity of institutional investors, suggesting the need for future studies to disaggregate investor responses based on characteristics like time horizon, ESG integration, or country of origin. Researchers can build on this work in several important ways. First, future studies could explore the long-term effects of reduced cash reserves on firms' innovation capabilities and investment decisions, helping to assess whether enhanced financial discipline under disclosure regulations supports or hinders sustainable growth.

Second, examining the impacts of mandatory disclosure in emerging markets or under varying regulatory environments would provide insight into how institutional, legal, and cultural differences shape firms' responses to environmental transparency requirements. Finally, scholars could incorporate qualitative research methods, such as executive interviews or case studies, to gain a deeper understanding of the internal decision-making processes that drive corporate behaviour in response to mandatory disclosures (Ioannou & Serafeim, 2015). These directions would enrich the literature by offering more nuanced, contextualised insights into the mechanisms and consequences of environmental reporting mandates.

Collectively, these findings reinforce the view that mandatory carbon disclosure is a powerful policy tool that reshapes both investor and corporate behaviour. It supports climate-related financial goals while improving financial market discipline. However, the full potential of disclosure mandates depends on thoughtful design, balanced implementation, and alignment with broader corporate and policy objectives. As global disclosure standards continue to evolve, stakeholders must navigate this changing landscape with a clear understanding of the interplay between transparency, governance, and financial outcomes. This thesis contributes valuable empirical insights to that ongoing conversation.

6.3 Thesis limitations

While this thesis provides novel and causal insights into the effects of mandatory carbon disclosure on institutional investment behaviour and corporate financial policy, several limitations must be acknowledged. These limitations, common in empirical research, present opportunities for future studies to build upon and enhance the generalisability and robustness of the findings.

First, my thesis faces data availability constraints, particularly regarding the sample of PRI-signatory investors analysed in Chapter 3. The number of PRI signatories was relatively small during the sample period, only 62 in 2006 and approximately 630 globally before the U.K.'s disclosure regulation in 2013, consistent with prior literature (Brandon et al., 2022). While the analysis provides early evidence of responsible investment behaviour, the limited sample size may reduce statistical power and affect the generalisability of findings related to responsible investing. Future studies could use updated datasets, given the rapid growth in PRI signatories in recent years, or supplement quantitative analysis with qualitative approaches (e.g. investor interviews) to better capture evolving ESG integration practices (Ioannou & Serafeim, 2015).

Second, this thesis focuses on U.K.-listed firms, leveraging the 2013 mandatory carbon disclosure regulation as a natural experiment. While this enhances causal inference, it limits the external validity of the findings. The U.K. has relatively high institutional investor engagement and strong climate norms, which may not be representative of other markets. For example, investors in countries with weaker ESG frameworks may be less responsive to carbon disclosures (Krueger et al., 2020). Future research could address this limitation by examining cross-country settings using staggered rollouts of climate disclosure policies, such as those introduced by the Task Force on Climate-related Financial Disclosures (TCFD)[24] across various jurisdictions. This would allow for comparative institutional analysis and further assess

[24] The Task Force on Climate-related Financial Disclosures (TCFD) is an international initiative established in 2015 by the Financial Stability Board (FSB) to develop a framework for companies to voluntarily disclose climate-related financial risks and opportunities in a consistent, clear, and comparable way. See https://www.fsb-tcfd.org/ for more details.

the role of national environmental norms, regulatory quality, and investor composition in shaping firm responses.

Third, the study period, particularly in Chapter 3, is restricted to a relatively short window (2010–2016) due to the limited availability of reliable, firm-level carbon emissions data. While this window captures short- to medium-term responses to the regulation, it may miss longer-term impacts on firm behaviour, valuation, and strategic investment, particularly in areas such as innovation or green technology adoption. This matters because some ESG and financial outcomes, like decarbonisation investments or reputation effects, may take years to materialise (Flammer et al., 2021). As more historical and forward-looking climate data become available, future studies could examine longitudinal effects of disclosure regulations, helping to uncover delayed or persistent outcomes in firm strategy and investor behaviour.

Fourth, although this thesis employs a rigorous causal identification strategy, including a difference-in-differences approach, endogeneity concerns cannot be entirely eliminated. Unobserved firm-level characteristics such as innovation capacity, board ESG expertise, or internal sustainability culture may influence both the firm's carbon performance and financial decisions. These omitted variables could bias the estimated effects of disclosure regulations. Future research could integrate additional firm-level indicators (e.g. board sustainability committees, R&D intensity, ESG scores) or apply machine learning-based matching methods to better control for firm heterogeneity. Combining quantitative and qualitative methods (e.g. case studies or executive surveys) could also offer richer insights into managerial motivations behind financial adjustments post-disclosure.

In sum, while the limitations discussed here do not diminish the core contributions of this thesis, they offer meaningful directions for future research. Addressing these issues through a broader geographical scope, longer time horizons, richer firm-level data, and more advanced causal inference techniques would allow for a more comprehensive understanding of how environmental transparency shapes financial markets and corporate behaviour across diverse institutional and regulatory contexts.

6.4 Suggestions for future research

In this section, I provide some directions for potential future research that build upon the findings of my thesis. First, while this thesis demonstrates that mandatory carbon disclosure attracts greater institutional investment and that firms with lower carbon emissions receive higher institutional ownership, the results show differently among types of institutional ownership. It would be valuable to examine whether the increase in ownership is driven by new institutional investors entering the firm or by existing investors expanding their holdings (new investors). This could provide deeper insights into how disclosure regulations reshape investor portfolios following the study of (Gibson Brandon et al., 2022; Marshall et al., 2022). Second, given the focus on U.K.-listed firms, future research could examine similar mandatory carbon disclosure or carbon reduction regulations in emerging markets, such as Thailand, where information asymmetry and agency issues are often more severe than in developed economies (Fan et al., 2011; La Porta et al., 1998). This would help assess the generalisability of the findings and evaluate the effectiveness of disclosure regulations in encouraging sustainable practices in emerging market contexts.

Third, it would be interesting to examine whether institutional investors investing in mandated carbon disclosure firms attract greater fund flows from individual investors. This would help understand whether good carbon performance and disclosure not only attract institutional capital but also influence the preferences of retail investors, reinforcing market discipline towards sustainability (Amel-Zadeh & Serafeim, 2018; Hartzmark & Sussman, 2019). Fourth, while this study focuses on equity markets, future research could examine whether other asset classes, such as private equity and fixed income, similarly respond to firm-level carbon performance (Brandon et al., 2022). Despite data challenges in these asset classes, understanding whether sustainable practices attract capital across securities would contribute to holistic insights into how climate-aligned investment strategies support the UN Sustainable Development Goals.

Fifth, the findings on mandatory carbon disclosure and reduced abnormal cash holdings suggest improved governance and capital allocation discipline. Future studies could examine intermediate channels, such as changes in stakeholder pressures, operational risks, or compliance costs, that drive liquidity adjustments following disclosure mandates (Harford et al., 2008). Extending these analyses to other countries would enhance the robustness of the findings. Additionally, while this thesis highlights heterogeneity among institutional investors in response to carbon disclosure, future studies could further explore how different investor characteristics, such as stewardship intensity, activism, and ESG integration, influence investment strategies across various environmental issues (Hoepner et al., 2016; Krueger et al., 2020).

Examining how domestic versus foreign institutional investors adjust to disclosure mandates (Marshall et al., 2022) would also contribute to understanding cross-border capital flows under climate policy frameworks. Moreover, integrating qualitative research methods, such as interviews with corporate executives and institutional investors, could offer deeper insights into board-level decision-making and organisational motivations underlying observed financial behaviours post-disclosure (Ioannou & Serafeim, 2015). Finally, as climate-related disclosure standards continue to evolve globally, ongoing research will be essential to assess their effectiveness in aligning market behaviours with sustainability goals and in reducing systemic climate risk. Future studies could also explore the long-term impacts of mandatory carbon disclosure on firm resilience, valuation, and risk management, providing a comprehensive understanding of how climate policy instruments shape corporate strategies and financial markets over time.

6.5 Concluding remarks

The process of investment decision-making is inherently complex and multifaceted, especially for institutional investors, who are widely recognised for their advanced analytical capabilities, information-gathering advantages, and expertise in evaluating financial and non-financial information from both public and private sources. This sophistication enables institutional investors to play a pivotal role in shaping market efficiency and influencing corporate behaviour. In parallel, the process of making corporate financing decisions, such as dividend payments and cash holding strategies, is equally complex, as firms must balance shareholder expectations, liquidity needs, and market perceptions while operating under evolving regulatory environments. Against this backdrop, this thesis has documented the effects of carbon intensity and mandatory carbon disclosure on firm financial decision-making and heterogeneous institutional investor preferences, contributing to the literature on sustainable finance and corporate financial policies under environmental regulation.

Regarding institutional investor preferences, the findings of this thesis suggest that institutional investors do not behave uniformly but instead display heterogeneous investment responses under different environmental and regulatory conditions. The empirical evidence shows that institutional investors, who differ in their investment horizons, monitoring intensity, and strategic objectives, react differently to changes in firms' carbon emissions and mandatory disclosure requirements. For example, those with a long-term investment, as well as investors who explicitly prioritise environmental responsibility, tend to increase their stakes in companies that successfully lower emissions once disclosure rules come into force. In contrast, short-term investors, who are typically focused on immediate returns, show much weaker reactions. This contrast highlights the diversity of investment behaviours within the institutional landscape. It also demonstrates that mandatory disclosure rules act as a catalyst, prompting some groups of investors to reward firms for sustainability improvements more strongly than others. As a result, institutional investors collectively play a central role in shaping corporate practices, but the influence they exert depends greatly on how they interpret and weigh environmental information in line with their own strategies and priorities.

From the corporate perspective, the findings demonstrate that mandatory carbon disclosure has broader implications beyond compliance, influencing key financial policies such as dividend payouts and cash holding behaviours. Firms subject to disclosure regulations tend to increase their dividend payouts and optimise cash holdings, suggesting that enhanced transparency and investor oversight reduce agency costs and improve governance. Overall, this thesis contributes to a deeper understanding of how environmental regulation, particularly mandatory carbon disclosure, interacts with institutional investment behaviour and corporate financial strategies. It underscores the interconnectedness of environmental sustainability and financial decision-making, demonstrating that climate-related transparency not only aligns firms with broader societal goals but also reshapes capital allocation in financial markets. As climate change continues to pose systemic risks to financial systems, insights from this thesis emphasise the importance of designing effective environmental policies that can engage institutional investors as key agents in promoting sustainable corporate practices while fostering financial stability. The evidence presented supports the view that integrating environmental considerations into financial markets can generate value for both investors and society, advancing the transition towards a more sustainable and resilient economy. Building on the foundation laid in this thesis, my future research will examine how climate-related financial disclosures shape firm innovation outcomes and investor activism across asset classes. I also aim to explore emerging regulatory environments, particularly in Thailand and Asia, where climate risk disclosures are rapidly evolving but remain underexplored in the academic literature.

As global climate risks intensify and capital markets face increasing pressure to respond, the role of financial economics in shaping sustainable corporate behaviour becomes ever more critical. This thesis contributes to that dialogue by empirically demonstrating how targeted policy tools, such as carbon disclosure mandates, can reorient investor behaviour and financial decision-making. Going forward, finance scholars, regulators, and practitioners must continue to collaborate in designing policies and investment frameworks that align private incentives with public environmental goals. This work marks a step in that direction.

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