Corporate Responses to the Climate Transition: Evidence on Transition Planning, Tax Planning, and R&D Investment

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Master of Commerce (Advanced)

Bachelor of Management (Business Administration)

Bachelor of Business Administration (Accounting)

This thesis is presented for the degree of Doctor of Philosophy of The University of Western Australia

Business School

Accounting and Finance

2026

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This thesis contains published work:

• Details of the work:

Sun, A. (Sistine), Shan, Y. G., Bayne, L., & Agarwal, N. (2026). Tax Planning Under Pressure: The Impact of Carbon Emissions Management Post–Paris Agreement. *Accounting & Finance*, 1–41.

• Location in thesis:

Chapter 3, entitled "Essay 2: Tax Planning Under Pressure: The Impact of Carbon Emissions Management Post–Paris Agreement".

• Student contribution to work:

I am responsible for data compilation and analysis, interpretation of the empirical results, and completion of the submitted draft.

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Acknowledgement

First and foremost, I would like to express my sincere gratitude to my supervisors, Associate Professor George Shan, Dr Lyndie Bayne, and Dr Nishant Agarwal, for their guidance, support, and encouragement throughout my doctoral studies. Their expertise, thoughtful advice, and constructive feedback have been invaluable at every stage of this research and have greatly shaped my development as a researcher.

I am deeply grateful to the Minerals Research Institute of Western Australia (MRIWA) for its generous financial support, without which this research would not have been possible. Special thanks to Dr Geoffrey Batt from MRIWA for his valuable support. I also gratefully acknowledge the support provided through the UWA-CSC HDR Top-Up Scholarship, UWA International Research Fees, the UWA GRS Overseas Travel Award, the HDR Research Publication Award, the HDR Thesis Submission Grant, and the Co-operative Education for Enterprise Development (CEED WA) program.

I am thankful to faculty members and participants of the UWA Brown Bag Seminars for their insightful comments, which significantly improved this research. My sincere thanks go to Professor Lee Smales, Professor Vincent Chong, Associate Professor Joey Yang, Associate Professor Kam Chan, and Dr Stijn Masschelein for their generous advice and professional support throughout my doctoral journey.

In addition, I appreciate the helpful feedback received from participants at the International Symposium on Carbon Accounting, Reporting and Sustainability; the Accounting and Finance Association of Australia and New Zealand (AFAANZ) Conference; the Illinois International Accounting Symposium and the Nanyang Business School Accounting Conference; the Minerals

Research Institute of Western Australia Showcase; the Australian PhD Conference in Economics and Business; the Curtin University Accounting Doctoral Colloquium; and the UWA Accounting Research Day. I also thank my friends and fellow PhD students for their encouragement and support throughout this journey.

Finally, I would like to thank my parents for their unwavering support, patience, and encouragement throughout my PhD journey. Their understanding and belief in me have been a constant source of strength.

Abstract

This thesis examines how firms respond to the climate transition through three connected choices: (i) whether the status of a firm's climate transition plan (no plan, plan in development, 1.5°C-aligned plan) is associated with subsequent changes in greenhouse gas (GHG) emissions, and whether this association is stronger when the plan signal is clearer and the reported outcomes are more verifiable (e.g., with third-party assurance); (ii) whether firms that reduce emissions following the Paris Agreement increase tax planning relative to other firms, and whether this increase is more pronounced when cost pass-through is constrained (e.g., in more competitive markets or among firms with weaker pricing power and financial flexibility); and (iii) in a carbon-intensive mining setting where climate pressure raises the importance of technological and process change, whether research and development (R&D) investment is priced as value-relevant information by capital markets, how quickly this pricing occurs, and which firm characteristics moderate the valuation relation. The thesis is presented in an integrated format comprising three research papers and two integrative chapters.

Study 1 examines whether the status of a firm's climate transition plan is associated with subsequent changes in GHG emissions. Using Carbon Disclosure Project (CDP) disclosures from 2022 to 2024, corresponding to fiscal years 2021 to 2023, across 57 countries and 11 GICS industry sectors, the study classifies firms' transition plan status into three categories: no plan, plan in development, and an adopted 1.5°C-aligned plan. The empirical results show that a firm's climate transition plan status is systematically associated with emissions performance, using both a directional measure of whether firms report an increase in total emissions and continuous measures of growth in total emissions (Scope 1 and Scope 2), direct (Scope 1) emissions, and indirect (Scope 2) emissions. Firms with 1.5°C-aligned plans are less likely to report increases in total emissions

and show slower growth in total emissions and direct emissions; however, these plans are not significantly associated with further slowing of indirect emissions growth. By contrast, firms with no plan are more likely to report increased total emissions and show faster growth in total and indirect emissions, while they are not significantly associated with growth in direct emissions. Firms with a plan in development are also more likely to report an increase in total emissions, but their plan status is not significantly associated with total emissions growth or direct emissions growth; however, it is associated with slower growth in indirect emissions, suggesting that early-stage planning may concentrate on areas where quicker operational gains are more achievable. The lack of a significant association between no plan or plan in development and Scope 1 emissions growth is consistent with the possibility that some polluting activities are shifted to subsidiaries.

The study also shows that these relations vary with context and disclosure verification. The associations are more pronounced in carbon-intensive industries and in countries with lower cultural concern for environmental issues, across both individual and societal dimensions, which is consistent with formal planning being more informative when external pressure is weaker. In addition, third-party assurance strengthens the associations between planning status and reported outcomes, supporting the role of assurance in improving disclosure credibility.

Study 2 examines whether firms' emissions-reduction responses after the Paris Agreement are associated with higher corporate tax planning. Using an international (non-United States) sample from 2011 to 2021 and a difference-in-differences design that treats 2016 as the implementation year, the study finds that GHG emissions-reducing firms are associated with higher levels of tax planning than non-emissions-reducing firms. The effect is stronger for firms facing tighter cost pass-through constraints, including those operating in more competitive markets, with weaker pricing power, or lower financial flexibility. The association is also more pronounced among firms with aggressive tax histories, higher agency costs, greater analyst coverage, and in civil-law countries. The evidence is consistent with climate-related cost pressure increasing firms' reliance on tax planning as an internal liquidity-preserving tool in the post–Paris Agreement period.

Study 3 examines, in a carbon-intensive mining context where environmental and social expectations increase attention to new exploration and processing methods, whether capital markets price R&D investment and under what conditions the valuation association is stronger or weaker. Using ASX-listed Australian junior mining firms (JMFs) from 2000 to 2019, a setting in which firms are resource constrained, often have limited operating cash flows, and undertake R&D infrequently, the study finds that higher R&D intensity is positively associated with firm value, with the strongest effects emerging over a two- to four-year horizon. In the entropy-balanced sample, a one-standard-deviation increase in R&D intensity is associated with an increase in Tobin's Q of about 0.38 three years later; evaluated at the sample mean of total assets (AUD 8.82 million), this corresponds to roughly AUD 3.35 million higher market value of equity, holding book values constant. The valuation association is stronger for JMFs with multinational operations, lower agency costs, lower financial distress, and for firms in the precious metals sector.

Together, the three studies provide integrated empirical evidence on how firms respond to the climate transition through interrelated choices in transition planning, internal financing, and R&D investment. It shows that formal climate transition planning is more closely associated with improved emissions trajectories when plans are ambitious and disclosures are verifiable, particularly in settings where external pressure is weaker. It further shows that when emissions reduction imposes near-term costs that are difficult to pass through, firms adjust their tax planning behavior in ways consistent with preserving internal liquidity. Finally, the thesis shows that in carbon-intensive industries where technological change is central to transition progress, capital markets do recognize R&D investment as value relevant, although such recognition is delayed and depends on firm characteristics related to financial capacity. These findings inform managers, investors, and regulators about the economic and environmental consequences of corporate climate transition actions, and highlight the importance of viewing transition planning, financial responses, and innovation investment as jointly determined rather than isolated decisions.

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Chapter 1. Introduction

Across sectors and regions, firms face increasing pressure from regulators, investors, and civil society to articulate credible climate transition pathways that are consistent with limiting warming to 1.5°C (CDP 2024). Recent guidance and reporting frameworks have increased expectations that firms move beyond general statements and provide decision-useful transition plans that enable monitoring of climate-related risks and progress (FSB 2025; IOSCO 2024; TPT 2023; CDP 2024). This policy focus reflects a broader shift toward evaluating firms' transition claims as inputs to market discipline and, in some contexts, financial stability assessment (FSB 2025). Yet prior research shows that firms' climate responses are shaped by both internal constraints (adjustment costs), and external constraints (stakeholder pressure and information demands), and that observed responses are often uneven across settings and firms (Bank and Wiesner 2011; Pinkse and Kolk 2012; Hoffmann et al. 2009; Linnenluecke et al. 2012; Rivera and Clement 2019).

This thesis examines how firms respond to climate transition through three connected choices. The first focuses on the credibility and content of corporate climate transition planning, and investigates whether stronger planning signals are associated with measurable greenhouse gas (GHG) emissions outcomes. The second considers internal financing under transition-related cost pressure and examines whether firms use tax planning to preserve liquidity when emissions reduction raises operating and compliance costs and cost pass-through is limited. The third concerns longer-horizon investment in innovation, and whether capital markets treat research and development (R&D) spending as value-relevant information in a carbon-intensive setting, the mining industry, where technical change is central to transition progress and financing frictions are material. The thesis is presented in an integrated format, comprising three research papers and two integrative chapters.

1.1. Motivation and research setting

An underlying policy premise behind transition-plan disclosure is that forward-looking plans reduce information gaps by clarifying how firms will adjust governance, strategy, and capital allocation in response to climate constraints (FSB 2025; IOSCO 2024; TPT 2023). In practice, transition-plan disclosure has expanded quickly. For example, transition plan disclosure is referenced in several standards and frameworks, and CDP has refined its transition-plan criteria toward a 1.5°C-aligned pathway, defining a credible plan as an actionable strategy to transition operations and business models toward net-zero by 2050 in line with limiting warming to 1.5°C (CDP 2022; CDP 2025). At the same time, policy interest has outpaced evidence on whether disclosed transition plans are associated with subsequent improvements in climate performance, as the existing literature has largely examined other climate-related actions such as adaptation, target setting, disclosure quality, or symbolic versus substantive engagement, with less direct attention to transition plans as a distinct strategic tool (Bui and De Villiers 2017; Liao et al. 2018; Coen et al. 2022; Moussa et al. 2022; Li 2025; Fan and Zhao 2025).

A related issue is disclosure credibility. Corporate climate actions are often communicated through voluntary disclosures and narratives, which can create scope for selective reporting when external verification is limited (Murillo-Luna et al. 2008; Boiral et al. 2012; Cooper and Slack 2015). Prior work also suggests that external assurance can serve both as a credibility signal and a disciplining mechanism that improves the reliability and impact of environmental disclosures (Du and Wu 2019; Liao et al. 2018; Maroun 2020). These arguments imply that transition-plan signals may be more informative when they are clearer and more verifiable, and that observed links between planning and outcomes may depend on whether reported emissions are subject to third-party verification or assurance. In addition, firms can adjust not only their emissions trajectories, but also the boundaries through which emissions are generated and reported. For example, prior evidence on offshoring suggests that firms may reduce certain local environmental impacts while shifting polluting activities to other entities or jurisdictions (Li and Zhou 2017). Together, these considerations motivate examining transition planning jointly with disclosure credibility and verification, rather than treating transition plans as uniformly informative across firms and settings.

A second motivation is that decarbonization can impose near-term costs. The Paris Agreement marked a major shift in global climate policy coordination, with countries committing to limit warming to well below 2°C and pursue efforts to limit it to 1.5°C (UNFCCC 2015). Since the Agreement, policy and enforcement attention has increased through mechanisms such as national commitments and carbon pricing, which can translate into higher operating and compliance costs for firms that reduce emissions (Christensen et al. 2021; Ehlers et al. 2022; Degryse et al. 2023). When these costs cannot be easily passed through to customers, firms may face liquidity pressure and rely more on internal funding tools. Tax planning is one such tool. Prior research treats corporate tax planning as a meaningful component of firms' capital management and financing decisions, and documents that tax planning can be used to conserve cash flows (Rego 2003; Desai and Dharmapala 2006; Dyreng et al. 2008). These arguments suggest that emissions reduction after the Agreement can be followed by higher tax planning, especially when firms face tighter constraints on cost pass-through or financing capacity.

A third motivation is that technological and process change is a core input to transition progress, particularly in carbon-intensive sectors. In mining, growing environmental and social expectations have increased attention on improved exploration and processing methods, which can involve innovation investment (Adler et al. 2017; Deloitte 2019). At the same time, junior mining firms (JMFs) are often resource constrained, have limited operating cash flows, and invest in R&D

infrequently,[1] which makes the valuation role of R&D an empirical question (Kreuzer et al. 2007; Iddon et al. 2015). Prior research establishes that R&D can be value relevant, but that uncertainty about innovation outcomes and commercialization prospects, together with limited disclosure and other information frictions, can delay or attenuate market recognition (Lev and Sougiannis 1996; Aboody and Lev 2000; Curtis et al. 2020). These features make Australian JMFs a useful setting for examining whether and when markets price R&D investment as informative about longer-horizon project value, and which firm characteristics strengthen or weaken the valuation association.

1.2. Overview of the three studies

The three studies are designed to be connected rather than standalone. Each study focuses on a different choice that firms face during the climate transition, but the choices share common drivers: institutional pressure, information credibility, and resource constraints.

Study 1 examines whether the status of a firm's climate transition plan is associated with subsequent changes in GHG emissions, and whether this association is stronger when the plan signal is clearer and reported outcomes are more verifiable. It uses CDP climate disclosures from 2022 to 2024 (covering fiscal years 2021 to 2023) across 57 countries and 11 GICS industry sectors and classifies firms into three categories: no plan, plan in development, and an adopted 1.5°C-aligned plan (CDP 2022; CDP 2024). The study evaluates emissions outcomes using both a directional measure of whether firms report an increase in total emissions (Scope 1 and Scope 2) and continuous measures of growth in total emissions (Scope 1 and Scope 2) and in direct (Scope 1) and indirect (Scope 2) emissions. The results show that 1.5°C-aligned transition plans reduce

[1] In Chapter 4, JMFs refer to firms legally incorporated in Australia (FIC) with a market capitalization of AUD 500 million or less (ASIC 2006).

the likelihood of reported emission increases in both groups, with a stronger effect among firms without assurance, while the effect of having a plan in development emerges only when disclosures are subject to third-party verification, consistent with the view that assurance improves disclosure credibility and reduces optimistic reporting (Du and Wu 2019; Liao et al. 2018; Maroun 2020).

Study 2 examines whether firms' emissions-reduction responses after the Paris Agreement are associated with higher corporate tax planning, and whether the association is stronger when near-term cost pressure is harder to absorb. Using an international (non-United States) sample from 2011 to 2021, the study applies a difference-in-differences design that treats 2016 as the implementation year for the post-Paris period. The results show that emissions-reducing firms increase tax planning relative to other firms, with stronger effects when cost pass-through is more limited (e.g., in more competitive markets or among firms with weaker pricing power) and when financing constraints are tighter, consistent with the view that tax planning is used to preserve internal liquidity under increased financing demands (Rego 2003; Desai and Dharmapala 2006).

Using ASX-listed Australian JMFs from 2000 to 2019, study 3 examines, in a carbon-intensive mining setting where environmental and social expectations increase attention on new exploration and processing methods, whether capital markets price R&D investment and under what conditions the valuation association is stronger. JMFs are characterized by high uncertainty, long project cycles, resource constraints, and infrequent R&D activity (Kreuzer et al. 2007; Iddon et al. 2015). The results show that markets do recognize R&D as value relevant in this setting, but that recognition is delayed and varies with firm characteristics related to governance and financial capacity.

1.3. Contributions and thesis structure

The thesis contributes evidence on how firms respond to the climate transition through interrelated choices in transition planning, internal financing, and innovation investment. First, by focusing on transition-plan status and subsequent emissions outcomes, Study 1 responds directly to growing policy interest in using transition plans as structured tools for evaluating climate-related risks and progress. Second, Study 2 connects decarbonization to corporate tax behavior in the post-Paris period, extending research that treats tax planning as a financing and cash-management tool by showing how climate-related cost pressure can map into tax decisions when cost pass-through and financing capacity are limited. Third, Study 3 extends evidence on the valuation of innovation investment by examining a carbon-intensive sector where technical change is central to longer-run transition progress, and where uncertainty and resource constraints make it unclear whether markets will treat R&D spending as timely, value-relevant information (Lev and Sougiannis 1996; Aboody and Lev 2000; Curtis et al. 2020). Collectively, these findings help clarify the empirical patterns in how firms' transition planning, tax planning, and R&D investment relate to emissions and valuation outcomes across settings, and provide evidence that may be useful for managers, investors, and regulators when assessing corporate transition disclosures and related firm responses.

The remainder of this thesis is organized as follows. Chapter 2 presents Study 1 on transition plan status and subsequent emissions outcomes. Chapter 3 presents Study 2 on emissions reduction after the Paris Agreement and corporate tax planning responses. Chapter 4 presents Study 3 on the valuation relevance of R&D investment in Australian JMFs. Chapter 5 concludes implications across the three studies.

Chapter 2. Essay 1: Climate Transition Planning and Corporate Climate Impact

2.1. Introduction

Across sectors and regions, firms face growing pressure to deliver credible 1.5 °C transition pathways under increasing scrutiny from regulators, investors and civil society (Carbon Disclosure Project [CDP] 2024). Recent policy developments and international guidance, such as the G20 Sustainable Finance Working Group's *Recommendations for Credible, Robust and Just Transition Plans* (2024) and the International Organization of Securities Commissions (IOSCO)'s *Report on Transition Plans* (2024), have elevated expectations for corporate climate planning. Regulators are beginning to codify these expectations. Over 30 jurisdictions now reference transition plan disclosure in International Sustainability Standards Board (ISSB)-aligned reporting, the UK's Transition Plan Taskforce (TPT) is informing forthcoming Financial Conduct Authority (FCA) rules, and the EU's Corporate Sustainability Reporting Standards (CSRD) and Corporate Sustainability Due Diligence Directive require firms to publish credible pathways, backed by European Financial Reporting Advisory Group's 2024 guidance. These developments reflect growing international interest in turning transition plans from aspirational statements into structured tools that may support market integrity and, potentially, financial stability, by providing forward-looking information relevant to monitoring climate-related risks (Financial Stability Board [FSB] 2025). However, their application in financial stability assessments remains at an early stage. Evaluating whether these plans are associated with improved climate performance is therefore a necessary first step in understanding their potential utility in regulatory and market contexts.

Despite the increasing policy attention given to climate transition planning, the existing literature has focused largely on firms' general climate strategies, with limited attention paid to their transition plans. Some studies highlighted the internal and external barriers to adaptation, including uncertainty, cognitive bias and costly exposures (e.g. Bank and Wiesner 2011; Pinkse and Kolk 2012; Bui and De Villiers 2017). Others emphasised that social awareness and physical climate events shape adaptation strategies in ways that are uneven and often reactive (Hoffmann et al. 2009; Linnenluecke et al. 2012; Rivera and Clement 2019). Recent research has pointed to a shift towards more proactive planning, where firms with high environmental, social and corporate governance (ESG) capabilities, strong governance and longer time horizons are better equipped to anticipate and manage climate-related risks (e.g. Fan and Zhao 2025; Li 2025; Luo and Tang 2021). Although prior research has examined a range of climate-related strategies, including adaptation responses, carbon target setting, risk disclosure and symbolic versus substantive engagement, most studies have focused on discrete practices or enabling conditions. However, the influence of climate transition planning on the climate change impact of firms has not been explored. This study addresses this gap by examining the association between firms' climate transition status, as defined in CDP responses, and their subsequent changes in emissions.

I conceptualise the climate transition status of firms as a continuum, ranging from low to medium to high, reflecting the clarity, ambition and implementation of their transition plans. Drawing on stakeholder theory, I argue that firms with high-status plans are more likely to achieve stronger climate performance, as supported by clearer commitments, stronger governance structures, more integrated internal capabilities and greater responsiveness to stakeholder pressures (Buysse and Verbeke 2003; Freeman 1984; Gallego-Álvarez and Ortas 2017). In contrast, firms with low-status planning tend to adopt reactive or fragmented responses that lack strategic integration (Luo and Tang 2021; Murillo-Luna et al. 2008), resulting in weaker climate performance and a higher likelihood of sustaining emission increases. Drawing from impression management theory, I further posit that firms in the centre of this spectrum, those disclosing intentions but lacking operational alignment, may engage in impression management, signalling alignment with external expectations without delivering substantive improvements in climate performance (Boiral et al. 2012; Cooper and Slack 2015).

This study uses recently introduced standardised disclosures from the CDP to examine how firms' climate transition planning is associated with subsequent changes in climate performance. I construct a multi-year panel dataset using CDP Climate Change Questionnaire responses from 2022 to 2024. I complement this dataset with firm-level financial and accounting variables from Compustat Global and Compustat North America, and country-level variables from the World Bank. The final sample consists of 5,102 firm-year observations across 57 countries and 11 Global Industry Classification Standard (GICS) industry sectors. The climate transition plan status of a firm is classified according to three levels: no plan, plan in development and adopted a 1.5 °C-aligned plan.[2] I examine their association with both categorical and continuous measures of changes in total, direct (Scope 1) and indirect (Scope 2) emissions.

The empirical results show that the level of a firm's climate transition plan status is systematically associated with its emissions performance. Firms with 1.5 °C-aligned plans are less likely to report emission increases, and they exhibit slower growth in total and direct emissions. However, these plans are not linked to further reductions in indirect emissions, possibly because most feasible Scope 2 measures have already been implemented. In contrast, firms without any plan report higher emissions and faster growth in both total and indirect emissions. One possible explanation for this is that firms without a transition plan, driven by profit-seeking motives, shift

[2] In 2022, the *Science Based Targets initiative* (SBTi) updated its criteria to require that all new targets align with limiting warming to 1.5 °C above pre-industrial levels. This benchmark reflects the most ambitious goal of the Paris Agreement. Accordingly, targets aligned with a 'well below 2 °C' pathway have not been accepted since July 2022.

the cost of carbon emissions offshore by relocating emission-intensive activities to foreign suppliers or affiliates, thereby mitigating their direct emission increases (Li and Zhou 2017). However, in the absence of a strategic plan, or even the intention to develop one, firms are less likely to manage indirect emissions from their remaining operations. As a result, Scope 2 emissions remain increased.

Firms with a plan in development are more likely to report an increase in emissions, but do not exhibit significant growth in either total emissions or direct emissions. However, these firms are associated with slower growth in indirect emissions, suggesting that early-stage planning may focus on areas where quicker operational gains are more achievable. I also find that the effects of transition planning status are more pronounced in carbon-intensive industries. The associations are also stronger in countries exhibiting lower cultural concern for environmental stewardship across both individual and societal dimensions, supporting the interpretation that formal planning can help compensate for limited external pressure. Finally, third-party assurance of emissions data moderates the association between planning status and reported outcomes, enhancing disclosure credibility and reducing the likelihood of inflated reporting.

This paper contributes to the existing research in several ways. First, to the best of my knowledge, this paper is the first to examine the association between the status of a firm's climate transition plan and the subsequent changes in its climate performance. This evidence enhances the understanding of whether and how the formalisation and ambition of transition planning affects real-world carbon outcomes. Prior studies have explored a wide range of firm responses to climate change, including adaptation strategies (e.g. Bui and De Villiers 2017; Li 2025), target setting (e.g. Dahlmann et al. 2019; Ioannou et al. 2016), disclosure quality (e.g. Liao et al. 2018) and symbolic versus substantive climate strategies (e.g. Coen et al. 2022; Moussa et al. 2022). However, little is known about the role of climate transition plans as a formalised strategic response, especially those plans aligned with the 1.5 °C target, which are widely regarded as the most credible and science-based approach to aligning corporate strategies with global climate goals (CDP 2024). By examining how the status of a firm's climate transition plan relates to its subsequent emissions performance, this study fills an important gap in the literature.

Second, my study contributes to the understanding of how contextual and governance factors influence the association between formal climate strategy and emissions performance. Using an international dataset, I examine variation across countries, industries and firms. Specifically, I find that the association between transition planning and emission outcomes varies with individual- and societal-level cultural attitudes towards environmental stewardship, industry carbon intensity and third-party assurance. This work enhances the broader literature by emphasising the importance of contextual elements in corporate climate strategy (e.g. Bui and De Villiers 2017; Li 2025).

Third, the findings contribute to ongoing policy discussions about the potential role of corporate climate transition plans (FSB 2025). As global standards such as International Financial Reporting Standards (IFRS) Sustainability Disclosure Standard 2, Climate-related Disclosures (IFRS S2), European Sustainability Reporting Standards (ESRS) and the TPT converge around expectations for credible and decision-useful planning, this study offers one of the first cross-country assessments of whether formal transition plans are associated with real-world decarbonisation outcomes. This evidence helps address the growing demand from regulators and financial stability authorities for forward-looking metrics that are comparable and grounded in observable results. These results suggest that transition plans can be particularly relevant in settings where cultural pressure for climate action is weak, indicating their potential to compensate for such limitations. Further, the finding that third-party assurance strengthens the relationship between planning status and reported outcomes reinforces recent policy calls for robust verification mechanisms as a condition for credible climate disclosures (IFRS 2024). From a corporate perspective, the findings suggest that developing a credible climate transition plan is not only a response to regulatory or investor expectations, but also a practical tool for improving climate performance in ways that can reduce compliance costs, support investor confidence and protect long-term value. Compared with ad hoc goals or aspirational statements, formal plans offer a coordinated roadmap that aligns internal operations, guides resource allocation and enables measurable progress. Firms without such plans may miss opportunities to improve operational efficiency, manage indirect emissions or meaningfully participate in climate-related disclosures.

The paper is organised as follows. Section 2.2 introduces the institutional background relevant to firm-level climate transition planning. Section 2.3 presents the literature review and develops the theoretical framework and hypotheses. The data and research design are described in Section 2.4, and Section 2.5 presents and discusses the empirical results. Section 2.6 features additional analyses, Section 2.7 reports robustness tests and conclusions are provided in Section 2.8.

2.2. Institutional background on firm-specific climate transition efforts

The 2015 Paris Agreement marked a significant shift in the global institutional response to climate change by committing to limit the global rise in temperature to well below 2 °C and pursue efforts to limit it to 1.5 °C. The first test of the Paris 'ratchet mechanism' culminated at the 28th UN Climate Change Conference with a global stocktake: a collective assessment of progress on the Paris Agreement goals. Despite reaching a historic agreement to transition away from fossil fuels, the stocktake failed to provide a crystal clear, actionable roadmap for implementation by all actors, although the critical role of companies is recognised (CDP 2024; TPT 2023). From a firm's perspective, with increased focus on clearer and tighter standards for companies to achieve global environmental goals, particularly where critical signals and evidence gaps remain, a pressing need exists to further define credible actions and support progress, particularly in transition planning (FSB 2025; IOSCO 2024).

The landscape of climate transition planning has progressed rapidly over the past several years. Climate transition plan disclosure is now required by several standards, including the IFRS S2 developed by the ISSB and the ESRS under the European Union's CSRD. The UK TPT published its final Disclosure Framework with the UK FCA, exploring how this guidance can support organisations disclosing transition plans under IFRS S2. Recognising the need for standardised and comparable disclosures, the CDP collected data on climate transition plans in 2021 and, in 2022, refined its criteria for climate transition plans from a 'low-carbon' transition plan to a climate transition plan that aligns with a 1.5 °C-aligned pathway (CDP 2022).[3] The CDP defines a 'credible climate transition plan' as a clear, actionable strategy outlining how a firm intends to transition its existing operations and business models towards achieving net-zero greenhouse gas (GHG) emissions by 2050, in line with limiting the rise in global temperature to 1.5 °C (CDP 2025). Essential elements of these plans typically include clearly defined governance structures, comprehensive scenario analysis, financial planning aligned with emission reduction targets and measurable, verified key performance indicators. Thus, by differentiating firms based on the clarity and ambition of their climate transition plans, the CDP provides valuable insights into varied strategic commitments across firms. Specifically, the CDP distinguishes between firms that report

[3] In 2021, the CDP asked, 'Have climate-related risks and opportunities influenced your organization's strategy and/or financial planning?' Since 2022, the question has been revised to 'Does your organization's strategy include a transition plan that aligns with a 1.5 °C world?'

having a 1.5 °C-aligned transition plan, those that are developing one and those that have no such plan (CDP 2022).

To enhance business resilience and avoid potential regulatory shocks, companies should, at a minimum, align their strategies with relevant Paris-aligned policy goals in jurisdictions where they operate, covering both direct operations and broader value chain activities (CDP 2022). Although CDP data show growing consistency in climate transition plan disclosures, progress remains uneven and slow, with considerable variation in the quality and depth of disclosures (CDP 2024). Given the increasing number of countries committed to net-zero emissions, it is critical to clearly identify the gaps between the stated ambitions and measurable outcomes of companies, enabling investors and other stakeholders to reliably assess the alignment of organisations' transition plans with this future.

2.3. Literature review and hypothesis development

2.3.1. Definition

In this study, 'transitioning' refers to taking actions that align a business model with a world in which two key outcomes are pursued: first, the global average temperature increase is limited to no more than 1.5 °C above pre-industrial levels; and second, the integrity, resilience and ecological function of ecosystems is restored, enabling a thriving economy that benefits people and the planet in the long term (CDP 2022). A credible climate transition plan is a time-bound action plan that sets out how an organisation will achieve the above, detailing how it will pivot its existing assets, operations and business model towards a trajectory aligned with the latest and most ambitious environmental science recommendations,[4] namely halving GHG emissions by 2030 and reaching

[4] As communicated by scientifically reliable and reputable institutions such as the Intergovernmental Panel on Climate Change (IPCC) and the SBTi.

net-zero by 2050 at the latest, thereby limiting global warming to 1.5 °C and ensuring that its business model will remain relevant (i.e. profitable) in a net-zero carbon economy (CDP 2022, 2024).

2.3.2. Prior research on firms' climate change mitigation and adaptation strategies

Extant research has identified several factors influencing firms' strategic climate change mitigation and adaptation. Qualitative evidence indicates that uncertainty, ambiguity and cognitive biases can limit a firm's adaptation to climate change (Bank and Wiesner 2011; Bui and De Villiers 2017; Linnenluecke et al. 2013; Pinkse and Kolk 2012). For instance, Bui and De Villiers (2017) constructed a theoretical framework using data from five New Zealand electricity generators, linking climate change risks and opportunities to strategic responses. They found that organisational strategies changed in response, moving from a stable strategy to various combinations of anticipatory, proactive and creative strategies, and finally regressing to a reactive strategy. They also identified regulatory uncertainty as the main constraint on proactive strategies and carbon management accounting development. In general, firms often struggle to accurately estimate climate impacts owing to the limitations associated with relying on historical data (Battiston and Monasterolo 2020). Managers, facing significant uncertainties, may rely on heuristics that are biased towards maintaining the status quo or inadequately preparing for future climate events (Dessaint and Matray 2017; Gavetti 2012). Moreover, the wide range of climate change effects means that adaptation to multiple exposures can be expensive (Kelly and Kolstad 2005), prompting some firms to offload these costs, possibly to governments (Keeler et al. 2022; Pindyck 2022).

Prior studies have also suggested that both social and physical factors may influence firms' mitigation and adaptation strategies. Socially derived factors involve an awareness and perception of climate change[5] (Berkhout 2012; Canevari-Luzardo et al. 2020; Pinkse and Gasbarro 2019). Climate change is an enormous social challenge, with complicated causal linkages spanning national boundaries and different time horizons that complicate their ready solutions (Bansal 2003; Pinkse and Gasbarro 2019). Within organisations, conflicting perspectives and interpretations of reality compete to define issues and develop solutions related to climate change (Daft and Macintosh 1981). Hoffmann et al. (2009) found that climate change awareness is a catalyst for adaptation among Swiss ski-lift operators. Physical factors, including direct climate experiences such as extreme weather events, also significantly shape adaptation strategies. Linnenluecke et al. (2012) proposed a conceptual framework examining organisational resilience to extreme weather. Empirical evidence provides mixed findings on the relationship between historical climate impacts and adaptation. Tashman and Rivera (2016) observed adaptive responses in US ski resorts related to historical snowfall variations, while Hoffmann et al. (2009) reported insignificant effects of past climate vulnerabilities among Swiss operators. Rivera and Clement (2019) identified an inverted U-shaped relationship between historical temperatures and adaptive actions in ski resorts.

A firm's climate strategy can vary substantially from reactive efforts to proactive approaches (Hart 1995). Moving beyond reactive adaptation, recent research has emphasised proactive strategic climate planning. For example, Li (2025) examined firms' adaptation strategies in the face of physical climate change exposure, showing that companies more frequently and comprehensively adapt when facing high-salience risks. The study highlighted that such adaptation is stronger in firms with higher ESG capabilities and longer-term planning horizons, suggesting

[5] 'Climate change awareness' refers to whether companies or people are aware of threats from climate change. 'Perceived impact of climate change' refers to how companies perceive and interpret the magnitude of the impact of climate change on their business operation and performance. The former is related to whether climate stimuli are noticed; the latter is associated with how climate impacts are being interpreted (Li 2025).

that climate exposure must be translated into an internal strategic response capacity to be effective. Fan and Zhao (2025) investigated how companies perceive and respond to climate-related risks and opportunities. They discovered that firms with a heightened awareness are more proactive in disclosing environmental information, which can influence investor perceptions and potentially reduce the financial risks associated with climate change. Ioannou et al. (2016) found that firms with more challenging emission reduction targets achieve those targets more effectively. Luo and Tang (2021) focused on the role of carbon strategy as a moderating mechanism between corporate governance and carbon performance. They observed that firms with high-quality governance structures are more effective in reducing emissions when they adopt well-defined carbon strategies and show a strong managerial awareness of climate risk.

Some studies showed how stakeholder pressure and governance systems influence firms' environmental strategies. For example, Buysse and Verbeke (2003) revealed that firms exposed to stronger stakeholder pressure are more likely to adopt proactive environmental strategies, including setting formal environmental targets and integrating environmental issues into strategic planning processes. Reid and Toffel (2009) further supported this view by showing that stakeholder influence, particularly from non-governmental organisations and institutional investors, increases the likelihood of firms publicly disclosing their climate change strategies. Bui et al. (2020) found that the integration of carbon management into corporate governance can improve the disclosure of carbon performance. Other studies emphasised that organisational contingencies affect climate strategy formulation. Galbreath (2011), through a case study of a global wine producer, showed that the level and breadth of corporate response to climate change depends on situated managerial attention, internal control systems and industry-specific characteristics. Lee and Klassen (2016) identified external uncertainty and internal organisational capabilities as key factors shaping firms' carbon management practices. Their findings indicated that firms with stronger organisational capabilities are more likely to implement proactive climate-related actions, even in uncertain regulatory or market contexts.

Several other studies distinguished between symbolic and substantive firm responses. Coen et al. (2022) differentiated between symbolic and substantive climate strategies. They found that only substantive climate strategies, characterised by concrete actions and transparent reporting, lead to meaningful emission reductions, highlighting the importance of strategic authenticity. Similarly, Dahlmann et al. (2019) examined whether the presence and nature of corporate climate change targets relate to environmental performance. They discovered that only substantive targets (those with high internal embeddedness, operational specificity and medium time horizons) are associated with performance improvements. In contrast, merely declaring carbon aspirations without governance follow-through yields little effect. Moussa et al. (2022) ascertained that the environmental target disclosure of UK firms varies with environmental performance and governance, with symbolic targets more common in sensitive industries, and substantive targets linked to stronger performance and environmental governance mechanisms, such as sustainability assurance.

In conclusion, these studies have shown that firms' climate-related strategies, whether framed as adaptation responses, carbon target setting or risk disclosure, are influenced by stakeholder pressures, governance systems and internal resources. Moreover, the nature and credibility of these strategies are crucial to their environmental impact. However, little is known about how firms vary in the clarity, ambition and implementation of their climate transition plans, or how these differences relate to their climate performance.

2.3.3. Theoretical framework and hypotheses

Firms exhibit varying levels of climate transition status, ranging from the absence of credible strategies to the adoption of clear, science-aligned commitments , such as 1.5 °C-aligned transition plans. This study conceptualises climate transition status along a continuum—low, medium or high—reflecting different levels in the clarity, ambition and implementation of firms' climate transition plans. To explain the heterogeneity in transition plan status and their associated climate outcomes, I draw on two complementary perspectives: stakeholder theory and impression management theory (Freeman 1984; Goffman 1959). According to Phillips (2003), a stakeholder is any individual, or group of individuals, that is the legitimate object of managerial or organisational attention. Impression management is closely related to stakeholder theory and provides an additional layer of understanding; it suggests that corporate climate strategy commitments provide organisations with effective tools to manage stakeholder perceptions (Cooper and Slack 2015; Neu et al.1998; Talbot and Boiral 2015).

Stakeholder theory is a frequently adopted theoretical perspective focusing on the need to manage particular stakeholder groups that have the power to provide firms with the required resources and support (e.g. Buysse and Verbeke 2003; Fan and Zhao 2025; Luo and Tang 2021). To ensure sustainability, a company must seek and maintain the support of its salient stakeholders (Freeman 1984). In the climate context, firms tend to develop climate strategies that respond to stakeholders' expectations to secure their support (Murillo-Luna et al. 2008). Murillo-Luna et al. (2008) empirically showed that firms adopt varying environmental response patterns, ranging from reactive to proactive, based on the degree and type of perceived stakeholder pressure. Their study categorised firms into four patterns: reactive, regulatory compliance, stakeholder engagement and total environmental quality. Firms with more proactive environmental strategies engage more deeply with salient stakeholders, particularly internal and primary stakeholders, thereby enhancing their environmental management effectiveness (Buysse and Verbeke 2003). Further, proactive carbon strategies foster higher-order learning, collaborative problem-solving and the integration of climate governance into daily operations (Gallego-Álvarez and Ortas 2017). These firms are better positioned to develop carbon management capabilities that are valuable, rare, inimitable and non-substitutable (Gouldson and Sullivan 2013), enabling them to manage their emissions more effectively. Transition plans that are aligned with the 1.5 °C target are characterised by robust targets, verified emissions accounting and board-level governance, and are positioned at the most advanced stage of the CDP's (2024) Transition Plan Journey (Step 5). This designation reflects that the firm has completed all foundational elements, such as governance, risk assessment and financial planning, and has publicly disclosed a credible transition plan. Therefore, adopting a 1.5 °C-aligned plan reflects a proactive climate strategy and the highest level of transition planning maturity. Firms with high transition plan status are therefore expected to achieve superior emission performance.

Hypothesis 1: Firms with high-status climate transition plans are more likely to achieve stronger climate performance

Although stakeholder theory explains strategic responsiveness, it does not fully capture why some firms might superficially adopt climate strategies without substantive actions. Prior research has shown that not all climate strategies adopted in response to stakeholder pressure are substantive (Boiral et al. 2012). In this context, impression management theory offers complementary insights. According to Goffman (1959), impression management theory refers to the process through which companies and people attempt to control or manipulate the reactions of others (e.g. stakeholders and relevant parties) to achieve their intended goals. Impression management theorists state that the primary motive of managers is to manage stakeholders' perceptions of their companies, and to avoid being viewed unfavourably (Cooper and Slack 2015; Talbot and Boiral 2015). Impression management theory suggests that firms use climate strategy rhetoric as a tool to manage a company's image and enhance its legitimacy through communications on its outputs, goals or methods of operations, without implementing meaningful change (Cooper and Slack 2015; Goffman 1959). Accordingly, I argue that firms with medium transition plan status, such as those making public commitments or disclosing future goals without embedding climate action into governance or operations, may be engaging in impression management to narrow the gap between stakeholder expectations and the firm's climate-related practices. Although these firms respond to stakeholder expectations with publicly disclosed climate intentions, strategic ambiguity can lead to poor coordination and operational inefficiencies (Abdallah and Langley 2014), ultimately limiting their impact on emissions.

Hypothesis 2: Firms with medium-status climate transition plans are likely to exhibit limited climate performance.

Conversely, firms with low transition plan status reflect a context in which stakeholder pressure for climate action is either weak, fragmented, or perceived as low-salience by management (Murillo-Luna et al. 2008; Buysse and Verbeke 2003). According to stakeholder theory, firms are motivated to develop and implement climate strategies primarily in response to the expectations and demands of their salient stakeholders (Freeman 1984; Murillo-Luna et al. 2008). When such pressure is absent or insufficiently coordinated, for instance, when institutional investors, regulators, or supply chain partners do not actively monitor or demand climate accountability, firms lack the external incentive to move beyond minimal compliance (Buysse and Verbeke 2003; Reid and Toffel 2009). In this low-pressure environment, managerial attention to climate risk remains limited, and the strategic integration of climate considerations into governance structures and operational planning is unlikely to materialise (Luo and Tang 2021). As a result, these firms typically adopt reactive approaches that prioritise narrow regulatory compliance over proactive strategy formulation, placing them at the least advanced stage of transition planning maturity (Murillo-Luna et al. 2008). Without the external accountability mechanisms and legitimacy pressures that salient stakeholders provide, these firms are unlikely to develop the internal systems, long-term planning horizons, organisational learning capabilities, and board-level governance structures necessary for effective carbon management (Gallego-Álvarez and Ortas 2017; Gouldson and Sullivan 2013). The absence of these capabilities leaves them poorly positioned to reduce emissions meaningfully, rendering them more exposed to climate-related transition risks and resulting in weaker climate performance overall (Cooper and Slack 2015; Luo and Tang 2021).

Hypothesis 3: Firms with low-status climate transition plans are more likely to experience weaker climate performance

2.4. Sample and research design

2.4.1. Data and sample

To examine the relationship between firms' climate transition planning and subsequent changes in their carbon emissions, I require data related to climate transition plans and climate performance. The primary sample comprises firms that responded to the CDP annual Climate Change Questionnaire, from which corresponding firm characteristics and emissions data are available. The CDP first formally introduced a dedicated question on climate transition plans in its 2022 questionnaire. Although earlier versions of the CDP questionnaire contained references to climate transition planning, the 2022 edition marks the first officially published version with a standalone, standardised item on transition plans (CDP 2025). To ensure consistency and comparability in the interpretation of disclosure content, I begin the sample in 2022. Although including earlier years may increase the sample size and capture long-term trends, the substantial changes to the question format and content could introduce measurement inconsistencies that would undermine the reliability of cross-year comparisons. Accordingly, my sample covers CDP questionnaire responses from 2022 to 2024, which correspond to fiscal years 2021 to 2023. I collect firm-level accounting and financial data from Compustat Global and Compustat North America for the fiscal years 2021–2023, and country-level data from the World Bank database. After merging these datasets and excluding incomplete observations, I obtain an initial sample of 5,102 firm-year observations across 57 countries. The sample construction procedure for the main regression analysis is described in Appendix 2.2.

Panel A of Table 2.1 presents the sample breakdown by year, while Panel B shows the sample breakdown by industry. Overall, my observations show a clear upward trend over time, with 24.11% from 2021, 35.48% from 2022 and 40.42% from 2023, indicating increased firm participation in climate transition reporting in these years. For the industry breakdown, I note that a considerable number of my observations are from the industrial (26.70%), consumer discretionary (15.76%), and materials (14.23%) sectors. These are followed by information technology (13.25%), consumer staples (9.56%), health care (5.94%), utilities (5.27%), communication services (4.45%), energy (3.02%), financials (1.45%) and real estate (0.37%). Panel C presents the country-level breakdown of firms according to their climate transition plan status. The firms are grouped into three categories: those with no transition plan, those currently developing a 1.5 °C-aligned plan and those that report having a 1.5 °C-aligned transition plan. The largest share of firm-year observations comes from Japan,[6] which accounts for 28.39% of the sample, followed by the United States (15.09%), the United Kingdom (7.11%), South Korea (5.51%) and France (3.74%). Countries with relatively high proportions of 1.5 °C-aligned transition plan firms include Switzerland, Chile, Austria and the Netherlands.[7] Firms classified as having a 'plan in development' dominate the sample in many countries. These country-level differences highlight substantial cross-jurisdictional variation in the adoption and maturity of corporate climate transition strategies.

Table 2.1. Sample distribution.

Panel A: Breakdown by year			
Year		Firm-years	% of Total
2021		1,230	24.11
2022		1,810	35.48
2023		2,062	40.42
Total number of observations		5,102	100
Panel B: Breakdown by industry			
GIC2	Industry Name	Firm-years	% of Total
10	Energy	154	3.02
15	Materials	726	14.23
20	Industrials	1,362	26.70
25	Consumer Discretionary	804	15.76
30	Consumer Staples	488	9.56
35	Health Care	303	5.94
40	Financials	74	1.45
45	Information Technology	676	13.25
50	Communication Services	227	4.45
55	Utilities	269	5.27
60	Real Estate	19	0.37
Total number of observations		5,102	100
Panel C: Breakdown by country			

[6] This is consistent with recent survey evidence from the CDP, which identified Japan as the leading country in credible climate transition plan disclosures in regional assessments (CDP 2024).
[7] It is important to note that some of the observed variation may be influenced by the number of firm-year observations per country. For instance, certain countries with high 1.5 °C-aligned plan percentages, such as Luxembourg or Kazakhstan, have relatively small samples, which may inflate percentage figures despite low absolute counts.

Country	*No Plan%*	*Plan in Development%*	*1.5°C-aligned Plan%*	overall	Firm-years	% of Total
Argentina	100	0	0	100	3	0.06
Australia	15	54	32	100	41	0.80
Austria	3	44	53	100	32	0.63
Belgium	0	58	42	100	38	0.74
Bermuda	29	50	21	100	14	0.27
Brazil	9	58	32	100	149	2.92
Canada	18	42	40	100	57	1.12
Cayman Islands	12	45	43	100	65	1.27
Chile	0	46	54	100	13	0.25
China	24	42	34	100	170	3.33
Colombia	0	50	50	100	4	0.08
Cyprus	0	33	67	100	3	0.06
Czech Republic	25	25	50	100	4	0.08
Denmark	2	54	44	100	48	0.94
Estonia	0	100	0	100	3	0.06
Finland	5	53	42	100	93	1.82
France	4	47	49	100	191	3.74
Germany	4	51	45	100	168	3.29
Greece	0	100	0	100	10	0.20
Hong Kong	0	53	47	100	15	0.29
Hungary	0	100	0	100	2	0.04
Iceland	0	83	17	100	6	0.12
India	1	48	51	100	151	2.96
Indonesia	0	60	40	100	5	0.10
Ireland	4	48	48	100	54	1.06
Israel	22	44	33	100	9	0.18
Italy	2	49	49	100	88	1.72
Japan	6	46	48	100	1449	28.4
Kazakhstan	0	33	67	100	3	0.06
Kuwait	0	33	67	100	3	0.06
Liberia	0	50	50	100	2	0.04
Lithuania	0	40	60	100	5	0.10
Luxembourg	11	53	37	100	19	0.37
Malaysia	0	67	33	100	12	0.24
Marshall Islands	0	100	0	100	2	0.04
Mexico	4	50	46	100	24	0.47
Netherlands	3	43	53	100	60	1.18
New Zealand	5	75	20	100	20	0.39

Nigeria	0	80	20	100	5	0.10
Norway	1	58	40	100	72	1.41
Panama	0	60	40	100	5	0.10
Philippines	0	78	22	100	9	0.18
Poland	16	68	16	100	19	0.37
Portugal	0	45	55	100	29	0.57
Russia	83	17	0	100	6	0.12
Saudi Arabia	0	50	50	100	2	0.04
Singapore	13	50	38	100	16	0.31
South Africa	14	58	29	100	73	1.43
South Korea	9	45	46	100	281	5.51
Spain	2	46	52	100	117	2.29
Sweden	2	50	48	100	134	2.63
Switzerland	5	49	46	100	85	1.67
Thailand	0	37	63	100	27	0.53
Turkey	0	42	58	100	52	1.02
United Arab Emirates	0	50	50	100	2	0.04
United Kingdom	3	56	41	100	363	7.11
United States	19	44	37	100	770	15.09
Total number of observations					5102	100

Note. This table presents the sample composition. Panels A, B, and C show the distribution of the sample by year, industry, and country, respectively. "% of Total" refers to the percentage of observations in each category relative to the total number of observations in the final sample.

2.4.2. Measuring climate change impact and climate transition plan status

I measure climate change impact using four complementary proxies derived from CDP data: *EmissionChange_Reported*, *EmissionChange_Continuous*, *Scope1Change_Continuous* and *Scope2Change_Continuous*. The first measure (*EmissionChange_Reported*) is a binary variable based on firms' responses to CDP Question C7.9, which asks how their gross global Scope 1 and Scope 2 emissions compare with the previous reporting year. The variable equals 1 if a firm reports that its emissions have increased, and 0 if its emissions have decreased. This indicator reflects a firm's self-reported directional change in emission performance and serves as my primary proxy for climate change impact.

To further explore the source-specific nature of emissions, I decompose total carbon emissions into those that are directly and indirectly related to the firm's activities. *Scope1Change_Continuous* and *Scope2Change_Continuous* represent the year-by-year change in firm-level direct and indirect emissions, respectively. Scope 1 (direct) emissions are caused by the combustion of fossil fuels or releases during manufacturing. Scope 2 (indirect) emissions originate from the purchase of electricity, heating or cooling (CDP 2022). Following Bolton and Kacperczyk (2021), I also use *EmissionChange_Continuous* to capture the year-by-year change in total carbon emissions (Scope 1 and Scope 2 combined).

Data on the transition plan status of firms are also sourced from the CDP. Specifically, I rely on responses to the question '*Does your organisation's strategy include a transition plan that aligns with a 1.5 °C world?*' Based on the response options, I construct three indicator variables representing the status of different transition plans. For each category, I construct a binary indicator (*No Plan*, *Plan in Development* and *1.5 °C-aligned Plan*, respectively), coded as 1 if the firm-year falls into that group, and 0 otherwise. Notably, firms reporting a climate transition plan with a different temperature alignment (i.e. not aligned with 1.5 °C) are grouped with those in development (*Plan in Development* = 1), since, effectively, they have not yet adopted a 1.5 °C-aligned plan, but are in the process of developing a climate transition plan. This response category was introduced only in the 2024 CDP questionnaire, and thus affects 2023 fiscal-year observations only. I exclude these firm-years in an untabulated robustness test, and the results remain unchanged. Each indicator is analysed separately in the full sample to examine how different levels of climate transition planning relate to climate change impacts.

2.4.3. Empirical model

I estimate the following ordinary least squares (OLS) regression model:

$$Y_{i,t} = \beta_0 + \beta_1 Plan_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 ROA_{i,t} + \beta_4 PPE\_AGE_{i,t} + \beta_5 SALEGR_{i,t} + \beta_6 NEW\_INVEST_{i,t} + \beta_7 INTANG_{i,t} + \beta_8 COUNTRY\_CO2_{i,t} + \beta_9 GDP_{i,t} + YEAR\ FE + INDUSTRY\ FE + COUNTRY\ FE + \varepsilon_{i,t} \tag{1}$$

where *Y* is a vector for the dependent variables used to capture firms' climate change impact, including *EmissionChange_Reported*, *EmissionChange_Continuous*, *Scope1Change_Continuous* and *Scope2Change_Continuous*. The key independent variable of interest, *Plan*, refers to the firm's climate transition plan status, categorised as *No Plan*, *Plan in Development* or *1.5 °C-aligned Plan*.[8] Each model includes one transition plan status indicator at a time, to evaluate its association with the dependent variables. All regressions control for firm-level characteristics and include year, industry and country fixed effects to account for time trends and unobserved heterogeneity.

[8] As a robustness check, I re-estimate Equation (1) using one-year-lagged *Plan* indicators to account for potential temporal misalignment between transition plan adoption and emission outcomes. The results do not alter the inferences (untabulated).

I control for a set of firm-level variables that may influence climate change impact. I construct and provide descriptions and brief motivations for variables that the prior literature has suggested may be linked to climate change performance. At the firm level, these variables comprise firm size (*SIZE*), profitability (*ROA*), capital equipment age (*PPE_AGE*), sales growth (*SALEGR*), new investment intensity (*NEW_INVEST*) and intangible asset rate (*INTANG*). All variables are defined in Appendix 2.1. Firm size (*SIZE*), measured as the log of total assets, captures various factors, including public pressure or the financial resources that motivate firms to respond to the CDP questionnaire (Matsumura et al. 2014) and to disclose additional information related to climate change (Clarkson et al. 2008; Dhaliwal et al. 2014). The level of carbon emissions and the firm's scale of operations are closely linked (Dahlmann et al. 2019). Firms with higher profitability (*ROA*), measured as earnings before interest and taxes divided by assets, have more financial resources with which to engage in activities to protect the climate and to meet the relevant compliance performance targets (Clarkson et al. 2011; Qian and Schaltegger 2017). Older production facilities are likely to generate more carbon emissions than newer ones. Thus, the age of the property, plant and equipment (*PPE_AGE*) is indicative of carbon emissions (Clarkson et al. 2008). I calculate *PPE_AGE* as the difference between the gross and net value of property, plant and equipment (PPE) divided by the depreciation. Since firms in an expansionary period have limited financial resources for climate change performance owing to financial constraints (Dhaliwal et al. 2012), I control for sales growth (*SALEGR*), measured as the percentage change in sales. In relation to growth, new investment intensity (*NEW_INVEST*), defined as the sum of research and development (R&D), capital expenditures, and acquisitions minus asset sales and depreciation, scaled by total assets, captures strategic reinvestment behaviour that may influence a firm's ability to transition to low-carbon operations (Dhaliwal et al. 2014). Intangible asset rate

(*INTANG*) is also included and calculated as intangible assets scaled by total assets, reflecting the knowledge- or innovation-based orientation of the firm.

In addition to firm-level control variables, I include several country-level controls to account for cross-country heterogeneity in environmental and economic conditions. Specifically, I control for the log of total national CO_2 emissions (*COUNTRY_CO2*) and the log of gross domestic product (GDP) per capita (*GDP*). The former captures the overall environmental pressure and carbon intensity associated with the firm's operating country, while the latter reflects the level of economic development and institutional capacity.

Finally, I follow prior studies on climate change impact (e.g. Ott and Schiemann 2023; Zhang et al. 2025) and include year fixed effects, industry fixed effects and country fixed effects. Year fixed effects (*YEAR FE*) account for unobservable macroeconomic and regulatory shocks that may affect all firms in a given year. Industry fixed effects (*INDUSTRY FE*), constructed based on GICS industry group codes, control for the production technologies and processes of individual industries that do not vary within industries. They also capture the heterogeneous use of carbon measurement methods in different industries (Ott and Schiemann 2023). Country fixed effects (*COUNTRY FE*) control for time-invariant institutional, legal or environmental factors at the country level that may shape firms' emission behaviour. I include firm-clustered standard errors throughout the tests in my study. All of the continuous variables are winsorised at the top and bottom one percentile to mitigate the effects of outliers.

2.5. Empirical results

2.5.1. Descriptive statistics and univariate analysis

Panel A of Table 2.2 reports the descriptive statistics for the main variables used in my analysis. The mean value of the main dependent variable, *EMISSIONCHANGE_REPORTED*, is 0.37, indicating that approximately 37% of firm-year observations report an increase in carbon emissions relative to the previous year. The alternative continuous measure of growth in emissions, *EmissionChange_Continuous*, has a mean close to zero (–0.02) and a standard deviation of 0.61, with a wide range from –7.09 to 7.23. Scope-specific measures (i.e. *Scope1Change_Continuous* and *Scope2Change_Continuous*) show similarly dispersed outcomes, suggesting no systematic bias in year-over-year changes in emissions across scopes. Regarding transition plan indicators, the descriptive statistics show that 8% of firm-years fall into the *No Plan* category, 48% are classified as *Plan in Development* and 44% report having a 1.5 °C-aligned transition plan (*1.5 °C-aligned Plan*). These distributions suggest that a substantial portion of the sample firms have taken steps towards, or fully adopted, 1.5 °C-aligned climate transition. For firm-level control variables, the average firm has log total assets (*SIZE*) of 10.69 and a PPE age of 8.6 years. The mean values of new investment intensity (*NEW_INVEST*), sales growth (*SALEGR*) and return on assets (*ROA*) are 3%, 12% and 5%, respectively. The average share of intangible assets (*INTANG*) is 16%, with notable variation across firms.

At the country level, the log of national carbon emissions (*COUNTRY_CO2*) has a mean of 6.36, and the log of GDP per capita (*GDP*) averages 10.52. The standard deviation of these country-level variables indicates substantial cross-country variation in environmental and economic conditions. Additionally, 74% of firms report having third-party assurance on carbon emissions data (*With Assurance* = 1). The mean values of *Carbon_Individual* (0.56) and *Carbon_Society* (0.30) reflect moderate variation in both individual environmental concern and societal climate attitudes. Approximately 35% of the sample is composed of carbon-intensive industries (*CARIN* = 1). These descriptive statistics are consistent with prior studies using multinational samples (e.g. Ott and Schiemann 2023; Zhang et al. 2025), suggesting meaningful variation in emission trajectories and transition planning across firms and jurisdictions.

Panel B of Table 2.2 displays group means of key firm-level variables across the 11 GICS industry sectors. The results show substantial variation in climate performance, transition planning and firm characteristics by sector. Firms in the utilities, energy and consumer discretionary sectors exhibit the highest rates of reported emission increases (*EmissionChange_Reported*), with the utilities sector showing the highest average (0.46), followed by energy (0.42) and consumer discretionary (0.40). Despite its high reporting rate, the utilities sector exhibits the second most negative average *EmissionChange_Continuous* (–0.07), following the communication services sector (–0.10). Across sectors, Scope 1 emission performance varies considerably, with the highest average increases observed in health care (0.06), while the largest average reductions appear in the utilities (–0.14) and real estate (–0.11) sectors. Mean Scope 2 emission growth (*Scope2Change_Continuous*) is negative in most sectors, indicating a broader trend of reduction in indirect emissions across industries.

In terms of transition planning, firms in the real estate and communication services sectors show the highest average likelihood of having a 1.5 °C-aligned plan (mean of *1.5 °C-aligned Plan* = 0.63 and 0.50, respectively), followed by firms in the utilities (0.49) and industrial (0.46) sectors. Health care, consumer staples and materials show a higher incidence of *Plan in Development* status, pointing to early-stage engagement with transition strategies. Third-party assurance practices also vary significantly across sectors. The utilities sector leads with the highest proportion of firms reporting assurance (0.92), followed by the energy (0.86), communication services (0.85) and real estate (0.84) sectors. Collectively, the industry-level summary indicates that transition planning and climate performance differ systematically across sectors. Carbon-intensive industries tend to show higher emissions but also demonstrate stronger engagement in climate verification and formal planning, reinforcing the need to control for industry fixed effects in regression analyses.

Panel C of Table 2.2 presents univariate comparisons of key firm and country characteristics between firms that have adopted a 1.5 °C-aligned climate transition plan and those that have not. Firms with such a plan are significantly less likely to report increased emissions (*EmissionChange_Reported*), with a mean of 0.28 compared with 0.43 for firms without the plan ($p < 0.01$). However, no significant differences are observed in the calculated emission growth (i.e. *EmissionChange_Continuous*, *Scope1Change_Continuous* or *Scope2Change_Continuous*), as measured by either mean or median tests. Firms with a 1.5 °C-aligned plan tend to be larger, with significantly higher average log asset values (*SIZE*) and slightly older capital stock (*PPE_AGE*). They exhibit slightly lower profitability (*ROA*) and sales growth (*SALEGR*) relative to firms without such plans. New investment intensity (*NEW_INVEST*) and intangible asset intensity (*INTANG*) do not differ significantly between the two groups. At the country level, firms with a 1.5 °C-aligned plan are more likely to be located in jurisdictions with lower total national CO_2 emissions (*COUNTRY_CO2*) and slightly lower GDP per capita (*GDP*). Verification practices differ substantially across the two groups. Among firms that have adopted a 1.5 °C-aligned climate transition plan, 85% obtain third-party assurance for their emission disclosures. In comparison, only 66% of firms without such a plan are externally assured. This difference is statistically significant at the 1% level ($p < 0.01$). Additionally, 36% of firms with a 1.5 °C-aligned plan

Table 2.2. Descriptive statistics.

Panel A. Full-sample descriptive statistics

Variable	Obs	Mean	SD	Min	P25	Median	P75	Max
EmissionChange_Reported	5,102	0.37	0.48	0.00	0.00	0.00	1.00	1.00
EmissionChange_Continuous	4,392	–0.02	0.61	–7.09	–0.11	–0.02	0.07	7.23
Scope1Change_Continuous	3,985	0.00	0.82	–12.12	–0.13	–0.02	0.10	12.35
Scope2Change_Continuous	3,650	0.00	0.71	–7.04	–0.13	–0.02	0.08	8.51
No Plan	5,102	0.08	0.28	0.00	0.00	0.00	0.00	1.00
Plan in Development	5,102	0.48	0.50	0.00	0.00	0.00	1.00	1.00
1.5°C-aligned Plan	5,102	0.44	0.50	0.00	0.00	0.00	1.00	1.00
PPE_AGE	5,102	10.69	2.64	4.17	8.72	10.48	12.51	16.72
NEW_INVEST	5,102	0.03	0.06	–0.12	0.00	0.02	0.05	0.38
SIZE	5,102	8.60	7.01	0.00	4.12	6.93	11.24	64.05
SALEGR	5,102	0.12	0.22	–0.39	0.01	0.09	0.19	1.15
ROA	5,102	0.05	0.07	–0.62	0.02	0.04	0.07	0.31
INTANG	5,102	0.16	0.19	0.00	0.02	0.07	0.25	0.81
COUNTRY_CO2	5,102	6.36	1.70	0.29	5.73	6.52	6.99	9.39
GDP	5,102	10.52	0.79	7.38	10.43	10.6	10.99	11.63
Carbon_Individual	4,211	0.56	0.06	0.49	0.52	0.55	0.60	0.88
Carbon_Society	4,584	0.30	0.11	0.02	0.26	0.28	0.31	0.74
With Assurance	5,102	0.74	0.44	0.00	0.00	1.00	1.00	1.00
CARIN	5,102	0.35	0.48	0.00	0.00	0.00	1.00	1.00

Panel B. Means by industry

GIC2	Industry Name	*EmissionChange_Reported*	*EmissionChange_Continuous*	*Scope1Change_Continuous*	*Scope2Change_Continuous*	*No Plan*	*Plan in Development*	*1.5°C-aligned Plan*	*PPE_AGE*	*NEW_INVEST*	*SIZE*	*SALEGR*	*ROA*	*INTANG*	*With Assurance*
10	Energy	0.42	–0.04	–0.05	0.03	0.16	0.44	0.40	10.42	0.02	10.08	0.23	0.06	0.08	0.86
15	Materials	0.37	–0.04	–0.03	–0.01	0.06	0.51	0.43	10.85	0.03	13.46	0.10	0.06	0.10	0.78
20	Industrials	0.36	–0.01	–0.02	–0.01	0.07	0.48	0.46	10.69	0.02	8.08	0.13	0.05	0.16	0.73

25	Consumer Discretionary	0.4	–0.02	0.02	–0.01	0.07	0.48	0.44	10.55	0.01	7.89	0.16	0.04	0.11	0.70
30	Consumer Staples	0.32	0.00	0.04	0.00	0.06	0.51	0.43	10.78	0.02	8.21	0.10	0.05	0.21	0.79
35	Health Care	0.37	–0.02	0.06	–0.03	0.08	0.53	0.39	10.49	0.07	5.56	0.08	0.05	0.27	0.68
40	Financials	0.46	–0.03	0.03	–0.07	0.20	0.47	0.32	11.61	0.01	3.10	0.10	0.03	0.25	0.82
45	Information Technology	0.33	0.04	0.03	0.05	0.15	0.47	0.38	10.37	0.06	6.38	0.09	0.06	0.16	0.62
50	Communications Services	0.34	–0.10	–0.03	–0.08	0.07	0.43	0.50	11.06	0.00	6.4	0.09	0.04	0.28	0.85
55	Utilities	0.46	–0.07	–0.14	0.09	0.08	0.43	0.49	11.17	0.03	12.78	0.19	0.03	0.11	0.92
60	Real Estate	0.32	–0.04	–0.11	–0.07	0.00	0.37	0.63	10.99	0.03	3.65	0.05	0.02	0.19	0.84

Panel C. Comparison Using if adopted 1.5°C-aligned Plan

Variable	Median (*1.5°C-aligned Plan*=1)	Mean (*1.5°C-aligned Plan*=1)	Median (*1.5°C-aligned Plan*=0)	Mean (*1.5°C-aligned Plan*=0)	Sig Difference (*p* value) (Median test)		Sig Difference (*p* value) (Mean test)	
EmissionChange_Reported	0.00	0.28	0.00	0.43	0.00	***	0.00	***
EmissionChange_Continuous	–0.02	–0.02	–0.02	–0.01	0.58		0.57	
Scope1Change_Continuous	–0.02	–0.01	–0.01	0.00	0.81		0.41	
Scope2Change_Continuous	–0.02	0.02	–0.03	–0.01	0.20		0.31	
PPE_AGE	10.92	11.18	10.03	10.31	0.00	***	0.00	***
NEW_INVEST	0.02	0.03	0.02	0.03	0.23		0.91	
SIZE	7.22	8.91	6.73	8.36	0.00	***	0.01	***
SALEGR	0.08	0.11	0.10	0.13	0.00	***	0.01	**
ROA	0.04	0.04	0.05	0.05	0.00	***	0.01	***
INTANG	0.07	0.16	0.07	0.16	0.71		0.65	
COUNTRY_CO2	6.52	6.3	6.52	6.41	0.00	***	0.03	**
GDP	10.43	10.50	10.60	10.54	0.00	***	0.09	*
Carbon_Individual	0.55	0.56	0.55	0.56	0.32		0.44	
Carbon_Society	0.28	0.30	0.31	0.29	0.86		0.40	
With Assurance	1.00	0.85	1.00	0.66	0.00	***	0.00	***

CARIN	0.00	0.36	0.00	0.34	0.17	0.17

Note. This table presents descriptive statistics. Panel A reports summary statistics for the full sample. Panel B shows variable means by industry, based on the GICS level-2 industry classification (GIC2). Panel C compares the distributions of key variables between firms with 1.5°C-aligned transition plans (*1.5°C-aligned Plan* = 1) and all other firms (*1.5°C-aligned Plan* = 0), including those with no plan or a plan in development. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

operate in carbon-intensive industries, compared with 34% among firms without such plans ($p < 0.01$), indicating that higher-emitting firms face stronger pressure to adopt ambitious climate transition strategies.

Since multicollinearity can arise when one independent variable is a linear function of a combination of others (Gujarati 2003), I assess multicollinearity using the variance inflation factor (VIF). Across all specifications, the highest individual VIF remains at approximately 1.3, with average VIFs close to 1.1, which are all close to 1. Thus, no evidence exists of a serious multicollinearity problem being present in the regression models.

2.5.2. Main results

Table 2.3 presents the main OLS regression results based on Equation (1), using *EmissionChange_Reported* as the dependent variable, a binary indicator for whether a firm reports increased emissions relative to the prior year (based on CDP responses). The independent variables of interest are the transition plan status indicators for whether a firm chooses *No Plan*, *Plan in Development*, or *1.5 °C-aligned Plan* in its business strategy. Column (1) shows that firms without a climate transition plan are significantly more likely to report an emission increase ($\beta = 0.055$, $p < 0.05$), corresponding to a 5.5 percentage point increase in the probability of emissions rising relative to the previous year. Similarly, Column (2) reveals that firms with a *Plan in Development* are 5.7 percentage points more likely to report an increase in emissions ($\beta = 0.057$, $p < 0.01$). In contrast, Column (3) shows that firms with a 1.5 °C-aligned plan are 8.9 percentage points less likely to report increased emissions ($\beta = -0.089$, $p < 0.01$). These results suggest that transition plan status is systematically associated with directional changes in self-reported climate impact.

Focusing on the control variables in the *EmissionChange_Reported* models, I find that across all three specifications, firms are less likely to report increased emissions if they have older capital equipment (*PPE_AGE*), are smaller in size (*SIZE*) and have greater intangible asset intensity (*INTANG*). The negative association between *PPE_AGE* and *EmissionChange_Reported* is somewhat unexpected, since older production facilities are generally assumed to be less energy efficient and more polluting (Clarkson et al. 2008). A possible explanation for this is that firms with older fixed assets may operate at lower production intensity, or may have already reached a stable plateau of emissions. Conversely, new investment intensity (*NEW_INVEST*) and sales growth (*SALEGR*) are consistently associated with a higher probability of reporting increased emissions.

Table 2.3. Baseline results: Transition plan status and reported emission increases.

Variable	DV=*EmissionChange_Reported*		
	(1)	(2)	(3)
No Plan	0.055**		
	(2.100)		
Plan in Development		0.057***	
		(3.711)	
1.5°C-aligned Plan			–0.089***
			(–5.435)
PPE_AGE	–0.003**	–0.003**	–0.003**
	(–2.267)	(–2.213)	(–2.213)
NEW_INVEST	0.416***	0.428***	0.428***
	(2.890)	(3.004)	(3.004)
SIZE	–0.023***	–0.018***	–0.018***
	(–5.015)	(–3.881)	(–3.881)
SALEGR	0.385***	0.386***	0.386***
	(10.218)	(10.272)	(10.272)
ROA	0.070	0.074	0.074
	(0.650)	(0.691)	(0.691)
INTANG	–0.197***	–0.199***	–0.199***
	(–4.012)	(–4.052)	(–4.052)
COUNTRY_CO2	0.376	0.368	0.368
	(1.534)	(1.511)	(1.511)
GDP	0.074	0.053	0.053
	(0.530)	(0.378)	(0.378)
Constant	–2.569	–2.306	–2.306
	(–1.529)	(–1.376)	(–1.376)
Observations	5,102	5,102	5,102
Adjusted R-squared	0.108	0.113	0.113
Year fixed effect	YES	YES	YES
Industry fixed effect	YES	YES	YES
Country fixed effect	YES	YES	YES

Note. The top row presents coefficient estimates, and the bottom row reports *t* values. All models control for standard errors clustered at the firm level. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

To provide complementary evidence, I re-estimate Equation (1) using continuous measures of emission change. Table 2.4 presents these results in three panels. Panel A reports results using *EmissionChange_Continuous*, a continuous measure capturing the year-over-year change in total carbon emissions. Column (1) of Panel A shows that firms without a transition plan experience significantly greater emission growth ($\beta = 0.078$, $p < 0.1$), while those with a 1.5 °C-aligned plan show significantly lower growth in emissions ($\beta = –0.037$, $p < 0.1$). The coefficient on *Plan in Development* is small and statistically insignificant. Although this may partially reflect a reduced sample size (from 5,100 to 4,392), owing to the requirement for two consecutive years of emission data, it may also indicate that firms in the development phase are still in the process of strategy formation or external signalling, with limited operational implementation.

In seeking to provide further insights, I decompose total emissions into direct (Scope 1) and indirect (Scope 2) components. Panel B uses *Scope1Change_Continuous* as the dependent variable. Scope 1 emissions reflect direct carbon outputs from a firm's owned or controlled operations, such as fuel combustion in production facilities, company-owned vehicles or industrial processes. In my analysis of *Scope1Change_Continuous*, the coefficient for *1.5 °C-aligned Plan* is negative and marginally significant ($\beta = –0.055$, $p < 0.1$), suggesting that firms with clearly defined climate transition strategies are associated with a reduction in direct emission growth. In contrast, neither *No Plan* nor *Plan in Development* is significantly associated with *Scope1Change_Continuous*. This may be consistent with offshoring some of the polluting activities to subsidiaries. For example, Li and Zhou (2017) found that a significant number of US firms reduce their pollution at home by offshoring production to poorer and less regulated countries.

Panel C examines *Scope2Change_Continuous*, reflecting indirect emissions from purchased electricity, heating or cooling. Firms without a transition plan are associated with significantly higher growth in Scope 2 emissions ($\beta = 0.139$, $p < 0.05$), while those with a *Plan in Development* show significantly lower growth ($\beta = -0.073$, $p < 0.1$). The *1.5 °C-aligned Plan*, however, is not significantly associated with further slowing of indirect emission growth. These findings suggest that firms in early-stage climate strategy planning (i.e. those with a *Plan in Development*) are inclined to support reductions in emissions in areas that are more easily adjusted through operational policies or procurement (Trivella et al. 2023), such as energy sourcing, efficiency upgrades or purchasing renewable electricity, where relatively quick gains can be achieved. In contrast, firms with more advanced transition plans may have already implemented most of the feasible Scope 2 measures, making further marginal reductions at later stages more difficult to achieve. This interpretation is consistent with my findings on Scope 1 emissions, where only clearly defined transition plans are associated with reduced growth in direct emissions.

Overall, these findings strengthen the interpretation of Table 2.3 by showing that the association between transition planning status and climate impact extends beyond self-reported emission increases to slower growth in actual emissions, as captured in Table 2.4. Specifically, while only well-defined, ambitious transition plans, such as those aligned with the 1.5 °C target, are significantly associated with meaningful improvements in firms' climate outcomes, in both reducing the likelihood of reported increases (*EmissionChange_Reported*) and slowing emission growth (*EmissionChange_Continuous*), some indication exists that firms with a *Plan in Development* are attempting to moderate their emission trajectory, particularly through reduced growth in Scope 2 emissions. In contrast, firms without any transition planning exhibit both the highest probability of reporting increased emissions and significantly greater emission growth, suggesting the environmental risks of strategic inaction.

Table 2.4. Transition plan status and continuous measures of emissions change.

Panel A. Total emissions change

Variable	DV=*EmissionChange_Continuous*		
	(1)	(2)	(3)
No Plan	0.078*		
	(1.768)		
Plan in Development		0.009	
		(0.448)	
1.5°C-aligned Plan			–0.037*
			(–1.794)
PPE_AGE	–0.004**	–0.004**	–0.004**
	(–2.337)	(–2.341)	(–2.306)
NEW_INVEST	0.234	0.231	0.232
	(1.126)	(1.113)	(1.121)
SIZE	–0.006	–0.007	–0.005
	(–1.085)	(–1.157)	(–0.808)
SALEGR	0.415***	0.417***	0.416***
	(4.416)	(4.408)	(4.413)
ROA	–0.167	–0.155	–0.157
	(–1.481)	(–1.395)	(–1.417)
INTANG	–0.098*	–0.102*	–0.101*
	(–1.681)	(–1.768)	(–1.759)
COUNTRY_CO2	–0.245	–0.249	–0.244
	(–0.617)	(–0.626)	(–0.615)
GDP	0.136	0.135	0.123
	(0.497)	(0.496)	(0.454)
Constant	0.183	0.230	0.317
	(0.061)	(0.077)	(0.106)
Observations	4,392	4,392	4,392
Adjusted R-squared	0.027	0.026	0.026
Year fixed effect	YES	YES	YES
Industry fixed effect	YES	YES	YES
Country fixed effect	YES	YES	YES

Panel B. Direct emissions change

Variable	DV=*Scope1Change_Continuous*		
	(1)	(2)	(3)
No Plan	0.070		
	(1.056)		
Plan in Development		0.032	
		(0.967)	
1.5°C-aligned Plan			–0.055*
			(–1.683)
PPE_AGE	–0.002	–0.003	–0.002
	(–0.916)	(–0.924)	(–0.897)
NEW_INVEST	0.137	0.133	0.140
	(0.374)	(0.365)	(0.383)

SIZE	–0.013	–0.012	–0.009
	(–1.141)	(–1.062)	(–0.798)
SALEGR	0.341***	0.342***	0.341***
	(3.002)	(3.010)	(3.003)
ROA	0.167	0.175	0.169
	(0.553)	(0.581)	(0.562)
INTANG	0.014	0.007	0.009
	(0.130)	(0.066)	(0.080)
COUNTRY_CO2	–1.048	–1.072	–1.060
	(–1.404)	(–1.439)	(–1.421)
GDP	–0.571	–0.573	–0.584
	(–0.656)	(–0.658)	(–0.671)
Constant	12.961	13.125	13.174
	(1.240)	(1.257)	(1.262)
Observations	3,985	3,985	3,985
Adjusted R-squared	0.057	0.057	0.057
Year fixed effect	YES	YES	YES
Industry fixed effect	YES	YES	YES
Country fixed effect	YES	YES	YES

Panel C. Indirect emissions change

Variable	DV=*Scope2Change_Continuous*		
	(1)	(2)	(3)
No Plan	0.139**		
	(1.981)		
Plan in Development		–0.073*	
		(–1.950)	
1.5°C-aligned Plan			0.031
			(0.822)
PPE_AGE	–0.009***	–0.009***	–0.009***
	(–3.183)	(–3.252)	(–3.223)
NEW_INVEST	0.721**	0.712**	0.711**
	(2.290)	(2.262)	(2.259)
SIZE	–0.009	–0.017	–0.014
	(–0.771)	(–1.319)	(–1.141)
SALEGR	0.445***	0.449***	0.450***
	(2.610)	(2.613)	(2.619)
ROA	–0.456*	–0.441*	–0.438*
	(–1.730)	(–1.688)	(–1.672)
INTANG	–0.049	–0.052	–0.055
	(–0.524)	(–0.555)	(–0.593)
COUNTRY_CO2	–1.515	–1.537	–1.546
	(–1.360)	(–1.382)	(–1.387)
GDP	1.444	1.477*	1.469
	(1.615)	(1.653)	(1.645)
Constant	–5.343	–5.430	–5.358
	(–0.445)	(–0.453)	(–0.447)

Observations	3,650	3,650	3,650
Adjusted R-squared	0.079	0.079	0.078
Year fixed effect	YES	YES	YES
Industry fixed effect	YES	YES	YES
Country fixed effect	YES	YES	YES

Note. This table reports OLS coefficient estimates from regressions of continuous emissions change measures on transition plan status. Panel A uses total emissions (Scope 1 and 2 combined) as the dependent variable; Panel B uses direct (Scope 1) emissions; and Panel C uses indirect (Scope 2) emissions. Sample sizes vary across panels (4,392; 3,985; and 3,650, respectively) because firms voluntarily disclose emissions by scope, resulting in differential data availability across emission categories. All regressions include year, industry, and country fixed effects and standard errors clustered at the firm level. *t*-statistics are reported in parentheses beneath coefficient estimates. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

2.6. Additional tests

2.6.1. Transition plan, cultural attitudes and climate outcomes

This section examines how cultural attitudes to environmental stewardship moderate the relationship between firms' transition plan status and climate performance. A firm's climate strategy can vary substantially from proactive approaches that go beyond compliance and require the development of specific capabilities to reactive solutions that meet only the minimum regulatory standards (Hart 1995). Culture exerts incremental influences beyond economic and regulatory incentives, and should therefore be adequately considered in the combat against global warming, particularly in negotiations for an international climate agreement that is more acceptable to societies with disparate cultural backgrounds (Luo and Tang et al. 2016). Prior studies have suggested that shared values, perceptions and awareness of climate change influence how firms interpret climate risks and design their strategic responses (Berkhout 2012; Canevari-Luzardo et al. 2020; Pinkse and Gasbarro 2019). Thus, in countries where more people consider it important to take care of the environment, individuals may find firms with more environmentally friendly policies appealing, thereby increasing the benefits to these firms. If a country's population is willing to pay more for products that are environmentally friendly, firms can cater to their preferences. For example, a firm can use environmentally friendly materials that are more expensive, passing the cost to consumers who are willing to pay the associated additional cost. Culture has the added benefit of guiding desirable or ethical choices, which can be nebulous. Citizens' support for governmental regulation of shared resources can result in the regulation of environmental stewardship practices (Bose et al.2023). One benefit of regulation is that it imposes common costs, making it more difficult for one firm to gain competitive advantage by not being environmentally friendly. Importantly, even the credible threat of regulation can serve as an incentive, with credibility more likely when citizens consider the environment a joint responsibility.

I expect that strong environmental cultural attitudes at the country level, whether through individual responsibility or societal support, can strengthen the environmentally responsible behaviour of firms. In such contexts, individuals are more aware of climate issues, and societal norms are more likely to exert informal pressure on firms to engage in credible climate action (Bose et al. 2023). As a result, the effectiveness of formal transition plans, such as 1.5 °C-aligned plans, may be reduced, since cultural attitudes already exert some influence on firm behaviour. Consistently, the adverse climate effects associated with having no plan or a plan still in development are expected to be mitigated in environmentally proactive cultures, where societal expectations and informal pressure may partially offset the lack of formal commitment. In countries with a weaker environmental culture, where such informal pressure is lacking, firms without a formal transition plan, or those with a plan still in the development stage, are expected to exhibit worse climate outcomes. In settings with a weaker environmental culture, formal transition plans are expected to play a more critical role in driving improvements in climate performance.

Measures of society's attitudes to the environment. I construct two proxies for cultural attitudes to the environment: *Carbon_Individual* and *Carbon_Society*. These measures are derived from the World Values Survey (WVS), which is a worldwide survey of cultural attitudes collected by social scientists. I match the closest cultural item response from the WVS wave to the year of the climate transition plan status data. I construct indices of related cultural attitudes and use the mean value for a country as a measure of the country's attitude to the environment. As Welzel (2013) explained, culture takes place at the group level; therefore, using the mean value of an attitude is useful as an aggregate measure of a country's attitudes.

The first index, *Carbon_Individual*, measures the extent to which individuals take personal action to improve the environment, such as choosing products that are better for the environment, recycling, reducing water consumption or being willing to pay more for a product to protect the environment. Following Bose et al. (2023), I construct *Carbon_Individual* using the following six WVS items to capture an individual's attitudes to (1) looking after the environment, (2) giving part of his/her income to environmental causes, (3) buying things at a 20% higher price if this helps to protect the environment, (4) choosing products that are better for the environment, (5) recycling and (6) reducing personal water consumption. The second measure, *Carbon_Society*, measures the tendency of a country to view environmental pollution as society's problem to resolve. This attitude may affect regulation or the potential for regulation. Items used to construct *Carbon_Society* include the extent of the agreement or action by individuals to undertake the following: (1) support an increase in taxes if used to prevent environmental pollution, (2) express the opinion that the government should reduce environmental pollution, (3) attend meetings or sign petitions to support the environment, (4) give money to an ecological organisation in the previous 2 years, (5) participate in demonstrations supporting the environment in the previous 2 years and (6) contribute to an environmental organisation.

Results on transition plan, culture attitudes and climate outcomes. To investigate the moderating role of cultural attitudes to environmental stewardship, I divide the sample based on the median values of two dimensions of country-level environmental culture: individual environmental responsibility (*Carbon_Individual*) and collective societal concern for environmental stewardship (*Carbon_Society*).[9] Table 2.5 presents the regression results estimated separately for the high- and low-value subsamples along each cultural dimension.

Panel A of Table 2.5 presents the regression results using *Emission_Increase_Reported* as the dependent variable, with the sample split based on *Carbon_Individual*. Consistent with my expectation, firms without a climate transition plan are significantly more likely to report increased emissions in low-concern countries ($\beta = 0.058$, $p < 0.1$ in Column 1), whereas the coefficient is statistically insignificant in high-concern countries (see Column 4). Similarly, firms with a *Plan in Development* are significantly more likely to report increased emissions in low-concern contexts ($\beta = 0.055$, $p < 0.01$ in Column 2), but the association is statistically insignificant in high-concern settings. These findings suggest that public expectations or informal pressure in high-concern environments may partially offset the negative effects of not having a plan. Having a *1.5 °C-aligned Plan* is associated with a significant reduction in reported emissions in both contexts, but the effect is stronger in low-concern countries ($\beta = –0.088$, $p < 0.01$ in Column 3) than in high-concern ones ($\beta = –0.063$, $p < 0.1$ in Column 6). This result suggests that in low-concern contexts, where individuals are less likely to engage in pro-environmental behaviour, formal and science-based transition plans can help compensate for limited individual-level engagement with environmental issues. By adopting structured and science-aligned transition strategies, such as

[9] The cut-off point is the sample median value of each cultural index. Since both indices are measured at the country level, the resulting subsamples differ in their number of firm-year observations, owing to the uneven distribution of firms across countries.

those consistent with the 1.5 °C target, firms respond to climate-related expectations in environments where bottom-up pressure from consumers or employees is limited. In contrast, in high-concern environments, where individuals are more inclined to act on environmental values, firms may be subject to greater informal accountability through individual-level expectations and behavioural norms, reducing the incremental influence of formal transition planning. Across all three comparisons, the coefficient equality tests yield p-values less than 0.001.

Panel B reports corresponding estimates using the same dependent variable, but split by *Carbon_Society*, which reflects societal-level concern for environmental stewardship. The *1.5 °C-aligned Plan* remains significantly associated with lower emission reporting in both groups, but the effect is stronger in countries with low societal environmental concern ($\beta = -0.103$, $p < 0.01$) than in high-concern countries ($\beta = -0.060$, $p < 0.1$). *Plan in Development* is positively and significantly associated with reported increases in emissions in low-concern countries ($\beta = 0.062$, $p < 0.01$), but not in high-concern settings. *No Plan* also shows a significant positive association in the low-value group only ($\beta = 0.074$, $p < 0.05$). These results indicate that in countries where societal concern for environmental issues is weak, climate transition plans may play a more salient role in guiding firm behaviour, since limited societal support exists for institutional or collective responses to environmental challenges. In contrast, where environmental protection is more widely regarded as a shared social responsibility, firms may face stronger expectations to act through the public endorsement of regulation and collective engagement. In such settings, climate transition plans may have limited incremental value beyond the existing societal expectations. Coefficient equality tests again yield p-values below 0.001 across all model pairs.

Table 2.5. Transition plan status, cultural attitudes, and climate impacts.

Panel A. Individual environmental concern						
Variable	DV=*EmissionChange_Reported*					
	Low Individual Concern			High Individual Concern		
	(1)	(2)	(3)	(4)	(5)	(6)
No Plan	0.058*			0.061		
	(1.720)			(1.191)		
Plan in Development		0.055***			0.030	
		(2.653)			(0.994)	
1.5°C-aligned Plan			–0.088***			–0.063*
			(–4.047)			(–1.942)
PPE_AGE	–0.001	–0.001	–0.001	–0.006*	–0.005*	–0.005*
	(–0.661)	(–0.704)	(–0.567)	(–1.802)	(–1.732)	(–1.753)
NEW_INVEST	0.412**	0.397**	0.410**	0.294	0.308	0.319
	(2.065)	(2.004)	(2.082)	–1.026	(1.076)	(1.122)
SIZE	–0.027***	–0.026***	–0.022***	–0.008	–0.009	–0.006
	(–4.238)	(–3.998)	(–3.303)	(–0.854)	(–0.928)	(–0.658)
SALEGR	0.393***	0.393***	0.390***	0.370***	0.376***	0.378***
	(6.359)	(6.356)	(6.327)	–5.746	(5.784)	(5.840)
ROA	0.162	0.167	0.156	0.231	0.241	0.234
	(1.110)	(1.143)	(1.066)	–1.095	(1.151)	(1.119)
INTANG	–0.124*	–0.132*	–0.125*	–0.333***	–0.334***	–0.334***
	(–1.804)	(–1.908)	(–1.797)	(–3.088)	(–3.116)	(–3.128)
COUNTRY_CO2	0.190	0.222	0.223	0.911**	0.860**	0.863**
	(0.484)	(0.574)	(0.577)	–2.094	(1.966)	(1.972)
GDP	0.190	0.153	0.140	–0.347	–0.326	–0.350
	(0.611)	(0.495)	(0.451)	(–1.331)	(–1.252)	(–1.340)
Constant	–2.701	–2.566	–2.418	–1.629	–1.527	–1.290
	(–1.038)	(–0.996)	(–0.937)	(–0.451)	(–0.421)	(–0.354)
Observations	2,787	2,787	2,787	1,420	1,420	1,420
Adjusted R-squared	0.120	0.121	0.124	0.191	0.191	0.192
Year fixed effect	YES	YES	YES	YES	YES	YES
Industry fixed effect	YES	YES	YES	YES	YES	YES

Country fixed effect	YES	YES	YES	YES	YES	YES
Test of equality of coefficients *p*-value (High vs. Low):	$p < 0.001$	$p < 0.001$	$p < 0.001$			

Panel B. Societal environmental concern

Variable	DV=*EmissionChange_Reported*					
	Low Societal Concern			High Societal Concern		
	(1)	(2)	(3)	(4)	(5)	(6)
No Plan	0.074**			–0.003		
	(2.347)			(–0.052)		
Plan in Development		0.062***			0.042	
		(3.199)			(1.367)	
1.5°C-aligned Plan			–0.103***			–0.060*
			(–5.085)			(–1.730)
PPE_AGE	–0.002	–0.002	–0.002	–0.003	–0.003	–0.003
	(–1.287)	(–1.328)	(–1.357)	(–1.273)	(–1.212)	(–1.092)
NEW_INVEST	0.420**	0.429**	0.434**	0.638**	0.632**	0.724**
	(2.126)	(2.183)	(2.223)	–2.291	(2.285)	(2.556)
SIZE	–0.012***	–0.011***	–0.008**	0.009	0.010*	0.009
	(–3.231)	(–2.939)	(–2.076)	–1.63	(1.740)	(1.506)
SALEGR	0.318***	0.326***	0.324***	0.384***	0.386***	0.394***
	(6.278)	(6.421)	(6.459)	–5.863	(5.865)	(5.377)
ROA	0.065	0.077	0.064	0.092	0.101	0.089
	(0.472)	(0.557)	(0.462)	–0.418	(0.464)	(0.422)
INTANG	–0.249***	–0.263***	–0.254***	–0.304***	–0.299***	–0.289***
	(–4.196)	(–4.426)	(–4.271)	(–3.381)	(–3.310)	(–3.102)
COUNTRY_CO2	0.043***	0.047***	0.041***	0.014	0.014	0.012
	(4.879)	(5.322)	(4.652)	–1.046	(1.024)	(0.839)
GDP	–0.012	–0.012	–0.012	–0.049***	–0.049***	–0.052***
	(–0.695)	(–0.704)	(–0.728)	(–2.845)	(–2.837)	(–2.962)
Constant	0.286	0.235	0.316*	0.728***	0.697***	0.791***
	(1.611)	(1.326)	(1.808)	(3.030)	(2.872)	(3.218)
Observations	2,931	2,931	2,931	1,425	1,425	1,416

Adjusted R-squared	0.084	0.085	0.090	0.136	0.137	0.157
Year fixed effect	YES	YES	YES	YES	YES	YES
Industry fixed effect	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES
Test of equality of coefficients *p*-value (High vs. Low):	$p < 0.001$	$p < 0.001$	$p < 0.001$			

Note. The top row presents coefficient estimates, and the bottom row reports t values. All models control for standard errors clustered at the firm level. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

2.6.2. Heterogeneity by industry carbon intensity

Certain industries are recognised as being more carbon intensive and facing greater challenges in reducing their carbon footprint, but they also have greater potential for substantial improvement, owing to higher public scrutiny and stakeholder pressure, tending to adopt stronger carbon management practices in response (Luo et al. 2012). Based on CDP (2008) classifications, carbon-intensive industries include mining and construction, textiles, printing and publishing, chemicals and pharmaceuticals, extractive, manufacturing, transportation and utilities. I construct an indicator variable, *CARIN*, which equals 1 for firms in carbon-intensive industries, and 0 otherwise. Table 2.6 presents the results. I find that the effects of climate transition plans are more pronounced in carbon-intensive industries across all plan categories. Specifically, firms without a transition plan are significantly more likely to report emission increases in carbon-intensive industries ($\beta = 0.110$, $p < 0.05$), but not in non-carbon-intensive ones. Similarly, having a *Plan in Development* is significantly associated with increased emission reporting in both carbon-intensive ($\beta = 0.057$, $p < 0.05$) and non-carbon-intensive groups ($\beta = 0.055$, $p < 0.01$), although the coefficient is slightly larger in carbon-intensive industries. Having a *1.5 °C-aligned Plan* is associated with a significantly lower likelihood of reporting emission increases across both groups, but the effect is larger in carbon-intensive industries ($\beta = -0.103$, $p < 0.01$) than in non-carbon-intensive ones ($\beta = -0.075$, $p < 0.01$). The association between transition planning status and climate impacts varies significantly across industry types.

The more pronounced emission increases observed among carbon-intensive firms without a plan, or with a plan still in development, reflect the fact that, in the absence of a formal strategy, it is particularly difficult for these high-emitting industries to effectively manage their climate goals. In contrast, the mitigating effect of a clearly defined 1.5 °C-aligned plan on emission increases is more pronounced in carbon-intensive industries. These findings suggest that the status of climate transition planning plays a more prominent role in high-emitting industries, where having a well-defined strategy is particularly important for managing climate outcomes.

Table 2.6. Heterogeneity by industry carbon intensity.

Variable	DV=*EmissionChange_Reported*					
	Carbon-Intensive Industries			Non-Carbon-Intensive Industries		
	(1)	(2)	(3)	(4)	(5)	(6)
No Plan	0.110**			0.026		
	(2.203)			(0.828)		
Plan in Development		0.057**			0.055***	
		(2.152)			(2.895)	
1.5°C-aligned Plan			–0.103***			–0.075***
			(–3.766)			(–3.696)
PPE_AGE	–0.003**	–0.003**	–0.003**	–0.001	–0.001	–0.001
	(–1.993)	(–1.974)	(–1.983)	(–0.418)	(–0.428)	(–0.369)
NEW_INVEST	0.447*	0.437*	0.450*	0.343*	0.347*	0.355**
	(1.855)	(1.786)	(1.868)	(1.922)	(1.957)	(2.001)
SIZE	–0.015*	–0.015*	–0.011	–0.031***	–0.028***	–0.025***
	(–1.926)	(–1.920)	(–1.457)	(–5.244)	(–4.839)	(–4.223)
SALEGR	0.272***	0.273***	0.272***	0.509***	0.512***	0.512***
	(4.831)	(4.849)	(4.848)	(9.465)	(9.502)	(9.549)
ROA	–0.111	–0.091	–0.103	0.166	0.176	0.167
	(–0.597)	(–0.494)	(–0.558)	(1.245)	(1.325)	(1.256)
INTANG	–0.232**	–0.236**	–0.237**	–0.146**	–0.150**	–0.148**
	(–2.450)	(–2.435)	(–2.463)	(–2.466)	(–2.528)	(–2.503)
COUNTRY_CO2	1.413***	1.409***	1.411***	–0.289	–0.316	–0.297
	(3.743)	(3.747)	(3.768)	(–0.882)	(–0.970)	(–0.911)
GDP	–0.194	–0.205	–0.226	0.316*	0.309	0.298
	(–0.906)	(–0.958)	(–1.054)	(1.670)	(1.629)	(1.567)
Constant	–6.333**	–6.208**	–5.971**	–0.875	–0.675	–0.648
	(–2.503)	(–2.468)	(–2.378)	(–0.374)	(–0.289)	(–0.277)
Observations	1,786	1,786	1,786	3,308	3,308	3,308
Adjusted R-squared	0.190	0.189	0.194	0.121	0.123	0.124
Year fixed effect	YES	YES	YES	YES	YES	YES
Industry fixed effect	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES
Test of equality of coefficients *p*-value (Carbon-intensive vs. Non-carbon-intensive):	$p < 0.001$	$p < 0.001$	$p < 0.001$			

Note. The top row presents coefficient estimates, and the bottom row reports t values. All models control for standard errors clustered at the firm level. ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

2.6.3. The moderating role of external assurance

Prior studies have shown that external assurance can serve as both a signal of credibility and a disciplining mechanism to improve the reliability and impact of environmental disclosures (e.g. Du and Wu 2019; Liao et al. 2018; Maroun 2020). To examine whether third-party assurance moderates the relationship between climate transition plans and emission outcomes, I use firm-level assurance information collected from CDP Question C10.1, which asks firms to indicate the verification or assurance status of their reported emissions. I construct a binary indicator, *Has_Assurance*, which equals 1 if a firm reports 'Third-party verification or assurance process in place' for either Scope 1 or Scope 2 emissions, and 0 otherwise. This classification allows us to compare firms that subject their emission disclosures to external scrutiny with those that do not.

Table 2.7 reports the regression results. The coefficients on *No Plan* are statistically insignificant in both subsamples (Columns 1 and 4), indicating that having no planning activity at all is not differentially associated with emission reporting behavior across assurance groups. However, I find that the presence of a 1.5 °C-aligned transition plan is significantly associated with a reduced likelihood of reported emission increases in both groups. The coefficient is larger (in absolute value) among firms without third-party assurance (β_1 = –0.088) than among those with assurance (β_1 = –0.073). The positive association between *Plan in Development* and reported emission increases is significant only among firms that obtain third-party assurance, suggesting that firms in the process of developing plans are more likely to report emission increases when their disclosures are subject to external verification. The findings are consistent with prior evidence showing that assurance enhances the credibility of non-financial disclosures (Du and Wu 2019). Specifically, firms lacking assurance are more inclined to report reductions when adopting formal plans, whereas those with assurance tend to report more cautiously. Taken together, my results suggest that third-party assurance plays a moderating role by improving reporting quality.

Table 2.7. Moderation by external assurance.

Variable	DV=*EmissionChange_Reported*					
	With Assurance			Without Assurance		
	(1)	(2)	(3)	(4)	(5)	(6)
No Plan	0.039			0.056		
	(0.999)			(1.391)		
Plan in Development		0.058***			0.030	
		(3.103)			(1.026)	
1.5°C-aligned Plan			–0.073***			–0.088**
			(–3.811)			(–2.497)
PPE_AGE	–0.003*	–0.003*	–0.003*	–0.001	–0.001	–0.001
	(–1.788)	(–1.726)	(–1.695)	(–0.604)	(–0.664)	(–0.571)
NEW_INVEST	0.488***	0.503***	0.504***	0.182	0.166	0.171
	(2.836)	(2.936)	(2.951)	(0.633)	(0.585)	(0.603)
SIZE	–0.016***	–0.014**	–0.012**	–0.026**	–0.028**	–0.025**
	(–2.732)	(–2.363)	(–2.152)	(–2.129)	(–2.309)	(–2.057)
SALEGR	0.359***	0.359***	0.359***	0.482***	0.492***	0.496***
	(8.574)	(8.537)	(8.568)	(5.529)	(5.649)	(5.696)
ROA	0.069	0.085	0.071	0.154	0.163	0.167
	(0.533)	(0.661)	(0.555)	(0.706)	(0.747)	(0.767)
INTANG	–0.209***	–0.210***	–0.208***	–0.044	–0.058	–0.058
	(–3.649)	(–3.654)	(–3.628)	(–0.401)	(–0.536)	(–0.540)
COUNTRY_CO2	0.569**	0.558**	0.563**	–1.147	–1.172	–1.157
	(2.239)	(2.200)	(2.218)	(–1.505)	(–1.540)	(–1.523)
GDP	–0.016	–0.049	–0.057	0.808**	0.804**	0.766*
	(–0.103)	(–0.310)	(–0.363)	(2.052)	(2.043)	(1.944)
Constant	–0.003*	–2.516	–2.405	–0.295	–0.072	0.240
	(–1.788)	(–1.350)	(–1.289)	(–0.067)	(–0.016)	(0.054)
Observations	3,786	3,786	3,786	1,306	1,306	1,306
Adjusted R-squared	0.135	0.137	0.139	0.044	0.043	0.048
Year fixed effect	YES	YES	YES	YES	YES	YES
Industry fixed effect	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES
Test of equality of coefficients *p*-value (Have vs. Have not):	$p < 0.005$	$p < 0.01$	$p < 0.05$			

Note. The top row presents coefficient estimates, and the bottom row reports t values. All models control for standard errors clustered at the firm level. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

2.7. Robustness tests

2.7.1. Self-selection bias

The sample may be subject to self-selection bias if firms that voluntarily disclose climate-related information to the CDP differ systematically from those that do not. Specifically, the unobserved factors influencing a firm's climate performance may also affect its decision to disclose this information, leading to biased estimates in the main analysis. To mitigate this concern, I implement Heckman's (1979) two-stage selection model. In the first stage, I estimate a probit model in Equation (2) to predict the likelihood that a firm responds to the CDP transition plan question, using the following specification:

$$CDP\_DISC_{i,t} = \beta_0 + \beta_1 PROPDISC_{i,t} + \beta_2\, CDP\_DISC\_LAG_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 ROA_{i,t} + \beta_5 PPE\_AGE_{i,t} + \beta_6 SALEGR_{i,t} + \beta_7 NEW\_INVEST_{i,t} + \beta_8 INTANG_{i,t} + \beta_9 COUNTRY\_CO2_{i,t} + \beta_{10} GDP_{i,t} + YEAR\ FE + INDUSTRY\ FE + COUNTRY\ FE + \varepsilon_{i,t} \qquad (2)$$

where the dependent variable, *CDP_DISC*, is an indicator equal to 1 if a firm responds to the CDP transition plan question, and 0 otherwise. To satisfy the exclusion restriction criteria in the first-stage model, two instruments are included: *PROPDISC*, which captures peer pressure to respond to the CDP within the same industry-year; and *CDP_DISC_LAG*, which indicates whether the firm disclosed its transition plan status in the previous year. *PROPDISC* is defined as the proportion of other firms in the same GICS industry and fiscal year that submitted a CDP response, excluding the focal firm. *CDP_DISC_LAG* equals 1 if the firm responded to the CDP transition plan item in the previous year. In the second stage, I re-estimate Equation (1), including the inverse Mills ratio (IMR) generated from the first stage, to correct for potential selection bias. Both instruments have non-zero coefficients in the selection equation and do not appear in the equation of interest, which satisfies the exclusion restrictions for the Heckman two-stage model. The results do not alter my inferences (see Table 2.8).

Table 2.8. Heckman's test.

Variable	DV=EmissionChange_Reported		
	(1)	(2)	(3)
No Plan	0.078**		
	(2.078)		
Plan in Development		0.080***	
		(3.697)	
1.5°C-aligned Plan			–0.103***
			(–5.129)
PPE_AGE	–0.006***	–0.006***	–0.006***
	(–3.192)	(–3.139)	(–3.242)
NEW_INVEST	0.523***	0.528***	0.532***
	(2.728)	(2.667)	(2.878)
SIZE	–0.005	–0.003	–0.001
	(–1.148)	(–0.606)	(–0.156)
SALEGR	0.252***	0.253***	0.254***
	(4.894)	(4.749)	(5.127)
ROA	–0.035	–0.019	–0.032
	(–0.236)	(–0.127)	(–0.228)
INTANG	–0.237***	–0.240***	–0.228***
	(–3.706)	(–3.644)	(–3.708)
COUNTRY_CO2	0.017***	0.017***	0.014**
	(2.799)	(2.821)	(2.494)
GDP	–0.045***	–0.042***	–0.045***
	(–3.161)	(–2.871)	(–3.228)
IMR	0.599**	0.619**	0.578**
	(2.316)	(2.319)	(2.317)
Constant	0.946***	0.854***	0.957***
	(4.332)	(3.770)	(4.546)
Observations	3,882	3,882	3,882
Year fixed effect	YES	YES	YES
Industry fixed effect	YES	YES	YES
Year fixed effect	YES	YES	YES

Note. The top row presents coefficient estimates, and the bottom row reports t values. All models control for standard errors clustered at the firm level. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

2.7.2. Two-stage least squares

To mitigate potential endogeneity concerns regarding the selection of firms into transition plan categories, I employ a two-stage least squares regression. Specifically, I instrument the three transition plan status indicators (*No Plan*, *Plan in Development*, and *1.5 °C-aligned Plan*) using *Industry_Alignment*, an industry-year measure of peer adoption pressure to adopt climate transition plans. The instrument is measured as the proportion of firms within the same industry and year that have adopted a 1.5 °C-aligned transition plan, excluding the focal firm. I expect industry-level plan adoption to influence a firm's own transition plan status through peer benchmarking and normative pressure, while remaining plausibly exogenous to its contemporaneous emission performance. The exclusion restriction is unlikely to be violated, since industry-level plan adoption is not expected to directly affect an individual firm's emission outcomes other than through its impact on the firm's own transition plan decision.

In the first-stage regressions, I regress each transition plan status indicator on *Industry_Alignment* and a full set of control variables. The Kleibergen–Paap Wald F-statistics across all three models exceed the Stock and Yogo critical value of 10, indicating that *Industry_Alignment* is not a weak instrument. As shown in Panel A of Table 2.9, the instrument is highly significant in each specification. In the second stage, I replace the endogenous transition plan indicators with their predicted values from the first stage and re-estimate Equation (1). The second-stage results, reported in Panel B of Table 2.9, remain qualitatively consistent with my main findings.

Table 2.9. IV approach.

Panel A. First Stage			
Variable	DV=*No Plan*	DV=*Plan in Development*	DV=*1.5°C–aligned Plan*
	(1)	(2)	(3)
Industry_ Alignment	–0.241***	–0.496***	0.736***
	(–5.02)	(–7.09)	（10.60）
PPE_AGE	–0.001***	–0.001	0.002
	(–2.62)	(–0.02)	（1.58）
NEW_INVEST	0.063	–0.139	0.075
	（–0.72）	（–1.13）	(0.60)
SIZE	–0.011***	–0.023***	0.034***
	(–6.44)	(–8.78)	(12.86)
SALEGR	0.006	–0.040	0.034
	(0.33)	(–1.34)	(1.20)
ROA	0.184**	–0.128	–0.056
	(2.55)	(–1.18)	(–0.52)
INTANG	–0.119***	–0.011	0.130***
	(–4.53)	(–0.25)	(2.99)
COUNTRY_CO2	0.026***	0.009**	–0.036***
	(7.62)	(2.11)	(–7.49)

GDP	0.023***	–0.002	–0.021**
	(3.83)	(–0.26)	(–2.16)
Constant	–0.146**	1.174	–0.028
	(–1.92)	(10.15)***	(–0.24)
Observations	5,102	5,102	5,102
Adjusted R-squared	0.055	0.257	0.320
Year fixed effect	YES	YES	YES
Industry fixed effect	YES	YES	YES
Country fixed effect	YES	YES	YES
Panel B. Second stage			
Variable		DV=*EmissionChange_Reported*	
	(1)	(2)	(3)
No Plan	0.665**		
	(2.199)		
Plan in Development		0.323**	
		(2.307)	
1.5°C-aligned Plan			–0.217**
			(–2.379)
PPE_AGE	–0.003**	–0.004***	–0.004***
	(–2.159)	(–3.631)	(–3.273)
NEW_INVEST	0.321**	0.408***	0.379***
	(2.287)	(3.123)	(2.985)
SIZE	0.004	0.004	0.004
	(0.875)	(0.900)	(0.931)
SALEGR	0.378***	0.395***	0.390***
	(10.162)	(10.667)	(10.847)
ROA	–0.160	0.003	–0.050
	(–1.238)	(0.030)	(–0.468)
INTANG	–0.180***	–0.256***	–0.231***
	(–3.185)	(–6.021)	(–5.380)
COUNTRY_CO2	–0.004	0.010**	0.005
	(–0.430)	(2.158)	(0.964)
GDP	–0.049***	–0.033***	–0.038***
	(–3.677)	(–3.293)	(–3.725)
Constant	0.901***	0.425**	0.798***
	(6.368)	(2.198)	(6.679)
Observations	5,102	5,102	5,102
Year fixed effect	YES	YES	YES
Industry fixed effect	YES	YES	YES
Country fixed effect	YES	YES	YES
Kleibergen-PaaprkWald F	25.208***	50.249***	112.288***

Note. The top row presents coefficient estimates, and the bottom row reports t values. All models control for standard errors clustered at the firm level. IV, instrumental variable. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

2.7.3. Entropy balancing method and propensity score matching (PSM)

The selection of firms into different climate transition plan categories may be systematically associated with firm-level characteristics, raising concerns about imbalance across comparison groups. To mitigate this, I first apply entropy balancing as a pre-processing step before estimation. Following Hainmueller (2012), I reweight observations such that the covariates used in each model are balanced across treatment groups on the first three moments (mean, variance and skewness). The treatment variable differs across models, depending on the transition plan status indicator under investigation (i.e. *No Plan*, *Plan in Development* or 1.*5 °C-aligned Plan*), and I conduct entropy balancing separately for each specification. The set of covariates used for balancing includes PPE age, investment intensity, firm size, sales growth, profitability, intangible asset intensity, total country-level emissions, GDP per capita and industry-average emissions (*Industry_CO2_Avg*). I then perform regression analyses using the re-weighted data. Columns (1)–(3) of Table 2.10 show that I obtain similar results to those reported in Table 2.3, suggesting that my inferences are not driven by observable differences in firm characteristics.

To further verify robustness, I also employ PSM. Specifically, I estimate the probability of being in each treatment category (*No Plan*, *Plan in Development*, *1.5 °C-aligned Plan*) using a probit regression that includes all control variables from the main regression. I then match treated firms with control firms using the nearest-neighbour matching technique (10 neighbours, caliper = 0.01, with common support imposed). The results based on the matched sample remain consistent, as shown in Columns (4)–(6) of Table 2.10.

Table 2.10. Entropy balancing method and PSM.

Variable	DV=*EmissionChange_Reported*					
	Entropy			PSM		
	(1)	(2)	(3)	(4)	(5)	(6)
No Plan	0.055**			0.062**		
	(2.086)			(2.230)		

Plan in Development		0.057***			0.058***	
		(3.728)			(3.754)	
1.5°C-aligned Plan			–0.089***			–0.088***
			(–5.455)			(–5.380)
PPE_AGE	–0.003**	–0.003**	–0.003**	–0.002	–0.003**	–0.003**
	(–2.270)	(–2.278)	(–2.217)	(–0.874)	(–2.283)	(–2.301)
NEW_INVEST	0.414***	0.417***	0.426***	0.568***	0.418***	0.460***
	(2.877)	(2.911)	(2.993)	(3.186)	(2.918)	(3.223)
SIZE	–0.023***	–0.022***	–0.018***	–0.025***	–0.022***	–0.018***
	(–5.032)	(–4.709)	(–3.892)	(–4.071)	(–4.687)	(–3.830)
SALEGR	0.386***	0.388***	0.387***	0.380***	0.388***	0.381***
	(10.233)	(10.251)	(10.287)	(7.691)	(10.262)	(10.039)
ROA	0.068	0.083	0.072	0.168	0.081	0.077
	(0.629)	(0.771)	(0.669)	(1.267)	(0.750)	(0.710)
INTANG	–0.197***	–0.201***	–0.199***	–0.228***	–0.203***	–0.189***
	(–4.005)	(–4.082)	(–4.043)	(–3.538)	(–4.136)	(–3.844)
COUNTRY_CO2	0.382	0.362	0.375	0.557	0.364	0.376
	(1.558)	(1.485)	(1.538)	(1.613)	(1.491)	(1.542)
GDP	0.078	0.071	0.056	–0.119	0.071	0.072
	(0.555)	(0.506)	(0.400)	(–0.605)	(0.507)	(0.510)
Constant	–2.646	–2.489	–2.383	–1.899	–2.500	–2.563
	(–1.571)	(–1.482)	(–1.419)	(–0.764)	(–1.488)	(–1.520)
Observations	5,102	5,102	5,102	3,016	5,097	5,059
Adjusted R-squared	0.131	0.133	0.136	0.135	0.133	0.136
Year fixed effect	YES	YES	YES	YES	YES	YES
Industry fixed effect	YES	YES	YES	YES	YES	YES
Country fixed effect	YES	YES	YES	YES	YES	YES

Note. The top row presents coefficient estimates, and the bottom row reports t values. All models control for standard errors clustered at the firm level. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

2.7.4. Sensitivity analyses excluding the US and Japan

During my sample period, the US had formally rejoined the 2015 Paris Agreement under President Biden, following a temporary withdrawal announced by President Trump in 2017. Given this regulatory volatility, as well as the US accounting for the second-largest share of firm-year observations in my sample (15.09%), I test the robustness of the results by excluding US firms from the analysis (Panel A of Table 2.11). I then conduct a separate test excluding Japanese firms (Panel B), which represent the largest share of the sample (28.39%), to mitigate concerns about country-level sample dominance. Finally, I repeat the analysis after simultaneously excluding both the US and Japan. Across all three specifications, the results remain qualitatively unchanged (Panel C).

Table 2.11. Sensitivity analyses excluding the U.S. and Japan.

Panel A. Excluding U.S. firms			
Variable		DV=*EmissionChange_Reported*	
	(1)	(2)	(3)
No Plan	0.075**		
	(2.426)		
Plan in Development		0.057***	
		(3.303)	
1.5°C-aligned Plan			–0.083***
			(–4.533)
PPE_AGE	–0.004***	–0.003**	–0.003**
	(–3.617)	(–2.486)	(–2.464)
NEW_INVEST	0.569***	0.466***	0.472***
	(3.190)	(2.636)	(2.689)
SIZE	–0.001	–0.024***	–0.021***
	(–0.294)	(–4.771)	(–4.103)
SALEGR	0.300***	0.390***	0.389***
	(7.510)	(9.594)	(9.609)
ROA	–0.023	0.032	0.025
	(–0.184)	(0.256)	(0.196)
INTANG	–0.277***	–0.168***	–0.168***
	(–5.399)	(–2.994)	(–3.015)
COUNTRY_CO2	–0.001	0.440*	0.456*
	(–0.145)	(1.786)	(1.851)
GDP	–0.060***	0.092	0.079
	(–4.989)	(0.651)	(0.563)
Constant	1.032***	–3.004*	–2.938*
	(6.993)	(–1.831)	(–1.791)
Observations	4,332	4,332	4,332
Adjusted R-squared	0.099	0.118	0.120
Year fixed effect	YES	YES	YES
Industry fixed effect	YES	YES	YES
Country fixed effect	YES	YES	YES
Panel B. Excluding Japanese firms			
		DV=*EmissionChange_Reported*	
	(1)	(2)	(3)
No Plan	0.078***		
	(2.583)		
Plan in Development		0.047***	
		(2.634)	
1.5°C-aligned Plan			–0.080***
			(–4.203)
PPE_AGE	–0.006***	–0.005***	–0.005***
	(–3.365)	(–2.834)	(–2.751)
NEW_INVEST	0.553***	0.441***	0.445***

	(3.628)	(2.906)	(2.949)
SIZE	0.005	–0.022***	–0.019***
	(1.398)	(–3.901)	(–3.350)
SALEGR	0.288***	0.371***	0.371***
	(7.118)	(8.962)	(9.021)
ROA	0.037	0.082	0.074
	(0.316)	(0.689)	(0.621)
INTANG	–0.320***	–0.237***	–0.234***
	(–6.305)	(–4.348)	(–4.307)
COUNTRY_CO2	0.016***	0.315	0.323
	(3.540)	(1.259)	(1.295)
GDP	–0.027***	–0.097	–0.116
	(–2.626)	(–0.499)	(–0.597)
Constant	0.564***	–0.327	–0.150
	(4.407)	(–0.139)	(–0.063)
Observations	3,653	3,653	3,653
Adjusted R-squared	0.107	0.125	0.128
Year fixed effect	YES	YES	YES
Industry fixed effect	YES	YES	YES
Country fixed effect	YES	YES	YES

Panel C. Excluding both U.S. and Japanese firms

Variable	DV=*EmissionChange_Reported*		
	(1)	(2)	(3)
No Plan	0.072*		
	(1.824)		
Plan in Development		0.043**	
		(2.030)	
1.5°C-aligned Plan			–0.068***
			(–3.021)
PPE_AGE	–0.007***	–0.006***	–0.006***
	(–3.404)	(–2.946)	(–2.901)
NEW_INVEST	0.627***	0.547***	0.547***
	(3.164)	(2.788)	(2.805)
SIZE	0.006	–0.023***	–0.021***
	(1.428)	(–3.624)	(–3.263)
SALEGR	0.283***	0.375***	0.375***
	(6.383)	(8.224)	(8.265)
ROA	–0.040	0.000	–0.004
	(–0.279)	(0.003)	(–0.027)
INTANG	–0.330***	–0.216***	–0.216***
	(–5.585)	(–3.393)	(–3.403)
COUNTRY_CO2	0.003	0.388	0.398
	(0.456)	(1.539)	(1.581)
GDP	–0.046***	–0.054	–0.070
	(–3.445)	(–0.279)	(–0.357)
Constant	0.838***	–0.984	–0.851
	(4.866)	(–0.433)	(–0.374)
Observations	2,882	2,882	2,882
Adjusted R-squared	0.121	0.140	0.141
Year fixed effect	YES	YES	YES

Industry fixed effect	YES	YES	YES
Country fixed effect	YES	YES	YES

The top row presents coefficient estimates, and the bottom row reports t values. All models control for standard errors clustered at the firm level. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

2.8. Conclusion

This study examined the association between the status of corporate climate transition plans and the subsequent changes in firms' climate performance. Using CDP disclosures from 2022 to 2024, corresponding to fiscal years 2021 to 2023, across 57 countries and 11 industries, I constructed a panel dataset that captured firms' transition plan status, categorised as *No Plan*, *Plan in Development*, or *1.5 °C-aligned Plan*, using four measures of emissions performance: self-reported increases and continuous growth in total, direct and indirect emissions. I found that firms with a 1.5 °C-aligned transition plan are less likely to report emission increases and exhibit slower growth in total and direct emissions. In contrast, it was found that firms without any plan are more likely to report increases and experience faster growth in both total and indirect emissions. Firms with a plan in development displayed mixed patterns: they reported emission increases but showed slower growth in indirect emissions, suggesting that early-stage efforts may target more achievable improvements. I further examined whether the observed associations vary with industry characteristics, country-level cultural attitudes and assurance practices. The effects of transition plan status were found to be more pronounced among carbon-intensive industries, and in countries with lower individual and societal concern for climate issues, suggesting that formal transition planning can help compensate for weaker external pressure. In addition, I discovered that third-party assurance strengthens the association between planning status and reported emission outcomes, suggesting the role of verification in enhancing disclosure credibility.

Overall, these findings provide empirical evidence that the level of formalisation and ambition in transition planning is meaningfully associated with emission outcomes. This evidence contributes to policy discussions about the value of transition plans as both a corporate strategy and a potential input to regulatory evaluation. Although these results do not establish causality, they provide evidence that transition plan status is relevant for climate-related performance, particularly in heterogeneous cultural environments.

I believe there are substantial opportunities for future research in this area. As an increasing number of jurisdictions are incorporating expectations for credible transition planning into corporate reporting standards (FSB 2025), understanding the real-world effectiveness of climate transition plans will become increasingly important. Firms that delay formalising their transition strategies may face growing regulatory, market and reputational risks, especially in carbon-intensive industries. Although this study focuses on the emission outcomes associated with transition planning status, future research could examine how other plan characteristics, such as implementation timelines, sector-specific actions or integration with financial strategy, shape both environmental and financial performance. Further work may also explore how investors and regulators interpret these plans, and how transition disclosures interact with broader climate governance mechanisms.

Appendix 2.1. Definitions of Variables.

Variable	**Definition**	**Data Source**
EmissionChange_Reported	A binary variable equal to one if the firm reports an increase in gross global Scope 1 and 2 emissions relative to the previous reporting year, and zero if it reports a decrease. Based on firms' responses to CDP *Question C7.9*.	Adapted from the CDP
EmissionChange_Continuous	A continuous variable capturing the year-on-year change in total carbon emissions (Scope 1 and Scope 2 combined).	Developed from the CDP
Scope1Change_Continuous	A continuous variable capturing the year-on-year change in firm-level direct (Scope 1) emissions.	Developed from the CDP
Scope2Change_Continuous	A continuous variable capturing the year-on-year change in firm-level indirect (Scope 2) emissions.	Developed from the CDP
No Plan	A binary variable equal to one if the firm reports not having a 1.5°C-aligned transition plan and indicates no intention to develop one in the near term, regardless of whether its strategy has been influenced by climate-related risks and opportunities. The variable equals zero otherwise.	Adapted from the CDP
Plan in Development	A binary variable equal to one if the firm indicates that it is developing a transition plan aligned with a 1.5°C world, and zero otherwise.	Adapted from the CDP
1.5°C-aligned Plan	A binary variable equal to one if the firm reports having an existing transition plan aligned with a 1.5°C world, and zero otherwise.	Adapted from the CDP
PPE_AGE	The age of a firm's property, plant, and equipment (PPE), calculated as the difference between the gross and net value of PPE divided by the depreciation.	Compustat Global & NA
NEW_INVEST	A firm's net investment activity, defined as the sum of R&D expenses, capital expenditures, and acquisitions, minus asset	Compustat Global & NA

Variable	**Definition**	**Data Source**
	sales and depreciation, scaled by total assets.	
SIZE	A firm size proxy, measured as the natural logarithm of total assets.	Compustat Global & NA
SALEGR	Sales growth, measured as the percentage change in total sales from the previous year.	Compustat Global & NA
ROA	Return on assets, calculated as earnings before interest and taxes divided by total assets.	Compustat Global & NA
INTANG	Intangible asset intensity, measured as intangible assets scaled by total assets.	Compustat Global & NA
COUNTRY_CO2	The natural logarithm of total national CO_2 emissions.	World Bank
GDP	The natural logarithm of GDP per capita.	World Bank
Carbon_Individual	Index measuring the extent of individual-level pro-environmental behaviors and attitudes, based on six items from the World Values Survey.	World Values Survey
Carbon_Society	Index measuring the extent to which individuals support collective and regulatory solutions to environmental problems, based on six items from the World Values Survey.	World Values Survey
CARIN	A binary variable coded as one if the firm belongs to a carbon-intensive industry, and zero otherwise.	Adapted from the CDP
With Assurance	Carbon assurance, a dummy variable that equals one if the company has assured either its Scope 1 or Scope 2 carbon emissions and zero otherwise.	Adapted from the CDP
PROPDISC	Industry pressure. The ratio of the number of firms with publicly available CDP responses to the total number of firms in the same industry.	Developed from CDP

Variable	**Definition**	**Data Source**
CDP_DISC_LAG	Prior year's CDP response. A binary variable equal to one if the firm submitted a CDP response in the prior year, and zero otherwise.	Developed from CDP
IMR	The inverse Mills ratio.	Own construction
Industry_Alignment	Peer adoption pressure for climate transition plans, measured as the proportion of firms within the same industry and year that have adopted a 1.5°C-aligned plan, excluding the focal firm.	Developed from the CDP
Industry_CO2_Avg	Average Scope 1 and Scope 2 emissions of other firms in the same industry-year, excluding the focal firm.	Developed from the CDP

Appendix 2.2. Sample Selection.

Selection Criteria	**Firm-year obs.**
CDP Climate Change Questionnaire respondents with matched Compustat and World Bank data, fiscal years 2021–2023	8,319
Less: firm-years with missing transition plan classification	(46)
Less: firm-years with missing dependent variable or control variables	(3,168)
Analytical sample	5,105
Less: singleton observations dropped by fixed effects estimator	(3)
Final sample	**5,102**
Unique firms	**2,331**
Countries	**57**

Note. This appendix describes the sample construction procedure for the main regression analysis. The initial sample comprises firm-year observations from the CDP Annual Climate Change Questionnaire for fiscal years 2021–2023, matched with firm-level financial data from Compustat Global and Compustat North America and country-level data from the World Bank database. Firm-years are excluded if transition plan classification is unavailable or if data required to construct the dependent variable or any control variable are missing. Singleton observations (i.e., firm-years that are the sole observation within a fixed effects cell) are dropped by the high-dimensional fixed effects estimator and do not contribute to the main regression estimates. Additional analyses may have fewer observations than the main sample.

Chapter 3. Essay 2: Tax Planning Under Pressure: The Impact of Carbon Emissions Management Post–Paris Agreement

3.1. Introduction

The Paris Agreement has triggered a wave of climate policy expansion, intensifying the regulatory and cost pressures on firms (Degryse et al. 2023). The Agreement articulates a legally binding global mechanism to accelerate action to mitigate climate change over time and establishes a long-term goal of limiting the global average temperature increase to well below 2°C and pursuing efforts to cap it at 1.5°C above preindustrial levels (Wu et al. 2022). This climate objective is accompanied by a legally binding review mechanism under which countries submit nationally determined contributions (NDCs), outlining mitigation and adaptation goals and identifying implementation challenges (including the means of implementation, such as technology transfer, capacity building and financing through the Green Climate Fund) as well as issues of comparability and equity (Salman et al. 2022; Stua et al. 2022).[10] The signatories to the Paris Agreement periodically assess progress through global stocktaking exercises that evaluate collective advancement towards the Agreement's objectives using the best available science (Bajaj and Thakur 2022). To achieve the goals from the NDCs, many jurisdictions have employed national carbon-pricing initiatives that detail the optimum pathways for achieving the objectives of the Paris Agreement. By 2021, 67 carbon-pricing initiatives, including carbon taxes and emissions trading schemes, had been implemented or scheduled at national and subnational levels (World Bank 2021).[11] This expansion of climate

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[10] Comparability refers to the ability to assess NDCs on a like-for-like basis, for example, differences in base years, metric definitions, and methodological choices. Equity concerns the fairness of burden sharing across countries, including considerations of historical emissions, capacity to pay, development needs, and climate vulnerability (UNFCCC 2022).

[11] Examples include Chile, which implemented its first carbon tax in 2017; Colombia, which introduced a carbon tax that same year as part of broader fiscal and climate reforms; Mexico, which expanded its carbon tax coverage and piloted an ETS between 2017 and 2018; and France, which progressively increased its carbon tax rate in the years following the Paris Agreement.

policy reflects the Agreement's influence in raising awareness of climate risks and encouraging policymakers to strengthen enforcement through the polluter pays principle (Organisation for Economic Co-operation and Development 1992), which aims to internalise greenhouse gas (GHG) emissions and incentivise low-carbon transition by imposing a financial cost on polluting behaviour (World Bank 2021; Errendal et al. 2023).[12]

Although the Paris Agreement has significantly influenced both policy development and global environmental efficiency (Salman et al. 2022; Stua et al. 2022), its firm-level financial implications remain insufficiently understood.[13] Climate-related cost shocks, including rising carbon prices, emissions taxes, and abatement and compliance costs, create a valuable setting to examine how firms adjust their financial strategies in response to climate-related cost pressures under the Paris Agreement. One important financial response of firms that has received little attention is how firms adapt their tax planning in the face of rising costs related to climate change mitigation policies. Corporate tax planning is an integral part of the capital management strategy of a firm (Rego 2003; Desai and Dharmapala 2006). Such planning involves the structuring of arrangements or transactions to take advantage of deficiencies in tax laws and regulations of a jurisdiction (Wilson 2009; Lisowsky 2010) or the differences in tax laws between jurisdictions (Atwood et al. 2012) to significantly reduce the amount of corporate taxes payable. I focus on the firm behaviour of tax planning because it offers a direct way for firms to free up internal financial resources without sacrificing operational output or growth investment, making it particularly attractive under cost pressures (Edwards et al. 2016). Moreover, tax planning is shaped by tax regulations (Haesner and

[12] This evolving legal–regulatory context has enabled formerly unprecedented interventions; for example, a Dutch court in 2021 ordered Royal Dutch Shell to accelerate its emissions reductions, overriding the company's own transition plan.
[13] For example, emerging evidence demonstrates that the Paris Agreement has intensified environmental performance among climate-exposed firms and led green banks to offer significantly cheaper and more flexible loans only after its ratification (Mbanyele and Muchenje 2022; Degryse et al. 2023).

Schanz 2013) and climate change mitigation is also subject to regulatory architecture, raising the question of how these two forms of regulation interact in a low-carbon economy. I contribute to the literature by examining whether the Paris Agreement affects firms' tax planning and by exploring the mechanisms through which climate-related cost shocks can affect tax-related financial decisions.

The Paris Agreement has increased both the strategic importance and the cost of developing environmental capabilities for firms (Degryse et al. 2023; Pang et al. 2023), making tax planning an attractive financial strategy for supporting the development of such capabilities. According to the natural resource-based view (NRBV), firms can build sustained competitive advantage through emissions reduction, clean technology innovation, and climate-ready supply chains (Hart 1995; Hart and Dowell 2011; Journeault 2016). Accordingly, the Paris Agreement strengthens firms' strategic incentives to invest in climate-related capabilities. Building and maintaining these capabilities requires sustained investment in abatement technologies, environmental reporting, and process transformation, entailing greater overall spending under strengthened regulatory and investor expectations for climate action since the Agreement (Pang et al. 2023). In the post–Paris Agreement period, lenders and investors have also priced firms' carbon exposure more explicitly in financing decisions, while regulators have imposed stricter disclosure requirements that increase compliance and verification costs (Christensen et al. 2021; Ehlers et al. 2022; Degryse et al. 2023). Firms must often absorb these costs internally when they cannot fully pass them on to stakeholders (Jacob and Zerwer 2024). While firms in the electricity sector may successfully shift carbon costs into output prices due to inelastic demand and minimal price-adjustment frictions (Fabra and Reguant 2014), most firms operate in more competitive markets and lack such pricing power. When cost pass-through is constrained, internal responses to climate-related cost pressures, such as cutting capital expenditure or shelving projects, can preserve liquidity but impair long-term productivity; relocating emissions-intensive facilities or stages of processing may preserve output but merely shift emissions (Bartram et al. 2022; Jacob and Zerwer 2024).

As corporate taxes represent a major expense item for a firm, management can be motivated to develop strategies to reduce the amount of corporate taxes payable to meet the firm's capital needs (Richardson et al. 2015). Under the cost pressures created by the Paris Agreement, tax planning becomes particularly attractive because it reduces tax liabilities, preserves cash flows, maintains credit ratings, and supports continuity (Richardson et al. 2015; Edwards et al. 2016), all of which are valuable when firms strive to meet goals for emissions reduction without compromising productive capacity. By legally reducing tax liabilities, firms can preserve cash flows and redirect funds to environmental capabilities without cutting operations or delaying investment. I therefore expect that firms facing climate-related cost shocks will rely more on tax planning as a resource reallocation tool and a strategic buffer.

While climate-related cost shocks, such as those induced by the Paris Agreement, are expected to increase firms' reliance on tax planning, the cross-sectional variation of this effect is important to understand. Drawing on previous literature (e.g. Fabra and Reguant 2014; Jacob and Zerwer 2024), I argue that the extent to which firms resort to tax planning to finance their NRBV-type investments depends on their cost pass-through capacity, which is influenced by two mechanisms. First, firms operating in highly competitive industries are less able to raise prices in response to cost shocks (Weyl and Fabinger 2013), limiting their ability to pass-through environmental abatement and compliance costs. This is because firms are price-takers in a perfectly competitive market and price-setters in a monopoly. Second, the relative elasticity of supply and demand; that is, firms can pass more (less) of their costs onto stakeholders when the firm is more elastic (inelastic) vis-à-vis its stakeholders (e.g. consumers in the product market or capital suppliers in the factor market) (Jacob and Zerwer 2024). Lower pass-through implies that firms bear a larger share of the cost, which in turn increases their reliance on internal adjustments such as tax planning.

Using an international panel of non–United States (US) firms from 2011 to 2021,[14] I estimate a difference-in-differences (DID) model that treats 2016 as the implementation year of the Paris Agreement. I measure tax planning as the gap between the statutory corporate tax rate and several effective tax rate constructs, and I identify exposure by whether a firm reduces its carbon emissions after 2016 relative to its own pre-Agreement baseline. The specification includes firm and year fixed effects and controls for firm- and country-level characteristics, including carbon-pricing regimes. Across specifications, firms that reduce emissions after the Paris Agreement increase tax planning relative to firms without such reductions. Results are robust to alternative tax-planning measures; entropy balancing; tests of the parallel-trends assumption; excluding the transitional year 2016; alternative clustering approaches; constant-sample restrictions and alternative test windows; and an alternative design based on non-signatory and late-ratifying countries.

Having established a robust positive association between the Paris Agreement and firms' tax planning, I then examine how this association varies across firm attributes and institutional contexts. Consistent with the limited cost pass-through mechanism, the increase is larger where cost pass-through capacity is lower, namely in more competitive markets and among firms with weaker pricing power, and where financial flexibility is more limited. These firms face greater difficulty passing on abatement and compliance costs to customers or raising external finance, which increases the share of costs borne internally and strengthens reliance on tax planning as an internal source of funds. The effect is also more pronounced among firms with a history of

[14] The US is excluded due to its distinct policy trajectory relating to participation in the Paris Agreement.

aggressive tax strategies, higher agency costs, greater analyst scrutiny, and in civil-law countries.

This study provides an incremental contribution to the extant literature in several ways. First, I extend the research on the Paris Agreement by identifying a previously unexplored firm-level adjustment channel: corporate tax planning. Prior studies on the Paris Agreement focus largely on its macroeconomic and environmental implications, such as improvements in global environmental efficiency (Salman et al. 2022). At the firm level, research has examined changes in financing and valuation, including green credit reallocation (Degryse et al. 2023); productivity effects (Pang et al. 2023); sensitivity of analysts' target prices to environmental, social, and governance (ESG) disclosure quality (Bolognesi and Burchi 2023); and market valuation effects (Chatjuthamard et al. 2024), while evidence on how firms adjust internal financial strategies remains limited. I complement this literature by showing that, in the post-Agreement period, firms engaged in emissions reductions significantly increase their tax-planning intensity compared with firms that are not engaged in emissions reductions. This finding provides new evidence about an under-researched financial response to large-scale environmental regulation, showing how climate policy can indirectly influence tax-base management behaviour at the firm level.

Second, I integrate the NRBV with cost pass-through framework to explain why firms differ in their tax responses to climate-related cost shocks. The NRBV helps explain why firms invest in environmental capabilities, whereas the cost pass-through framework clarifies how financial constraints influence how they fund these investments through financial adjustments such as tax planning. Prior studies using the cost pass-through mechanism (e.g. Fabra and Reguant 2014; Jacob and Zerwer 2024) examine how environmental cost shocks, such as emissions taxes, are transmitted through firms' investment decisions. I extend this line of analysis to another margin of adjustment, namely corporate tax planning, which serves as a documented mechanism for generating internal cash flow when real adjustments, such as investment cuts, are not feasible (Edwards et al. 2016). My results reveal that firms facing tighter pass-through constraints—because of factors such as operating in more competitive markets and having weaker pricing power and lower financial flexibility—absorb a larger share of these costs internally and rely more on tax planning as a liquidity-preserving tool. By linking the NRBV's resource investment logic with the economic incidence of cost pass-through, this framework provides an integrated explanation of how climate policy shocks translate into heterogeneous corporate financial behaviour.

Moreover, by utilising an international context, the study avoids the limitations of drawing conclusions from the analysis of a single region (Linnenluecke et al. 2016) and illustrates how the effects of the Paris Agreement vary across firms and countries based on their pre-Agreement characteristics and institutional environments. I contribute to knowledge by showing that the post-Agreement intensification of tax planning varies systematically with firm- and country-level characteristics, being more pronounced among firms with a history of aggressive tax strategies, higher agency costs, greater analyst scrutiny and in civil-law countries.

These findings also offer practical insights for policymakers. Climate measures such as carbon pricing can unintentionally encourage firms with limited cost pass-through capacity to rely more on tax planning, which may reduce the stability of the country's tax base and create broader fiscal consequences. This evidence suggests that climate policy can influence fiscal outcomes through firms' behavioural adjustments. Overall, the results imply that closer coordination between climate and tax policies could mitigate such unintended financial responses.

3.2. Background and Context

On 12 December 2015, 195 countries reached an agreement on a new climate treaty, known as the Paris Agreement.[15] This agreement marked a significant shift in climate negotiations sponsored by the United Nations (UN), transitioning from the top–down mandates of previous protocols to a more flexible framework that emphasises national discretion and accountability, thereby pressuring firms to reduce their GHG emissions (United Nations 2015).[16] Following the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, which aimed to stabilise GHG concentrations in the atmosphere to prevent dangerous anthropogenic interference, the international community spent over two decades negotiating legally binding regulations to control global emissions (UNFCCC 2021). Despite the adoption of the 1997 Kyoto Protocol and related mechanisms such as the Clean Development Mechanism, global emissions of major GHGs (e.g. carbon dioxide, methane, and nitrous oxide) continued to rise. Unlike the Kyoto Protocol's top–down and relatively narrow approach (Harstad 2023), the Paris Agreement introduced a more inclusive, flexible and politically sustainable framework based on NDCs. Under this framework, all countries are required to set emissions-reduction commitments. These national pledges are subject to periodic evaluation through a legally binding review architecture designed to assess collective progress towards long-term climate goals using the best available science (Stua et al. 2022; Bajaj and Thakur 2022). This shift in global climate governance has made the Paris Agreement more influential than its predecessors in shaping both national policy agendas and corporate behaviour with empirical evidence demonstrating that the policy intervention of the Paris Agreement has been conducive to the global environmental efficiency by reducing the level of GHG emissions (Salman et al. 2022).

[15] In all, 196 parties, comprising 195 countries and the EU, agreed to the deal.
[16]For more information, please visit the UN official website: https://unfccc.int/process-and-meetings/the-paris-agreement.

The requirement for countries to regularly submit and update their NDCs has created an ongoing cycle of review and accountability, reinforcing expectations for consistent progress and enabling external scrutiny (Dannenberg et al. 2023). These mechanisms translate international climate commitments into concrete policy and regulatory signals that shape firm-level decisions. Many countries have adopted national climate strategies that reflect strong emissions-reduction ambitions. For example, India's strategy includes enhancing its installed electric capacity from non-fossil fuel sources to approximately 50% of total installed capacity by 2030 (Ministry of Environment, Forest and Climate Change, Government of India 2022). New Zealand's *Climate Change Response (Zero Carbon) Amendment Act 2019* targets net-zero emissions of all GHGs, except biogenic methane, by 2050, with specific methane reduction goals (Ministry for the Environment, New Zealand 2019). Indonesia aims to reduce emissions by up to 41% with international support by 2030 (ASEAN Secretariat 2021). These strategies shape long-term expectations for corporate behaviour.

In addition to goal-setting strategies, some jurisdictions have implemented market-based mechanisms and regulatory tools that exert direct financial pressure on firms to internalise the cost of carbon. A prominent example is the European Union's (EU's) European Green Deal, which aims to make Europe the first climate-neutral continent by 2050 through a comprehensive legislative package (European Commission 2020). Central to this strategy is the European Union Emissions Trading System (EU ETS), which has been expanded to cover high-emitting sectors such as aviation and maritime transport, alongside a tighter emissions cap. Firms operating under the EU ETS must either innovate to reduce their emissions or purchase emissions allowances, effectively embedding a carbon cost into operational and investment decisions. Complementing this is the Carbon Border Adjustment Mechanism, which imposes a carbon price on imports from countries with weaker climate policies. This mechanism is designed to prevent carbon leakage and ensure that European firms do not face unfair competition, while also incentivising global trading partners to adopt stronger climate regulations (European Commission 2023). Similarly, China has made significant progress in developing its national carbon market. After conducting regional pilot programmes in cities such as Beijing, Shanghai and Shenzhen, China launched a national emissions trading scheme covering 2,162 power-generation companies and approximately 4.5 billion tons of carbon dioxide emissions. These initiatives form part of China's broader climate goals to peak emissions by 2030 and achieve carbon neutrality by 2060 (UNFCCC 2021).

At the firm level, the Paris Agreement has intensified regulatory expectations around climate disclosure and emissions management, prompting firms to take a more structured approach to decarbonisation (Degryse et al. 2023). Prior to 2015, few companies had made meaningful commitments to reduce their carbon emissions. However, the Paris Agreement catalysed a global wave of corporate pledges, with a notable increase in firms adopting science-based targets and incorporating climate goals into core business strategies (Aldy et al. 2023). Supporting this trend, data from Carbon Disclosure Project (CDP) (2017) also indicates a substantial increase in firms publicly reporting emissions and outlining transition plans.

Corporate decarbonisation involves not only tracking and reporting emissions but also undertaking mitigation and compliance strategies, such as reducing emissions directly or purchasing allowances, often at substantial financial cost (Salman et al. 2022). For example, Bartram et al. (2022) estimate that firms covered by California's Cap-and-Trade Program face incremental allowance costs of approximately USD20 million, equivalent to approximately 9% of average tax expenses, with the burden rising to approximately 15% for the most affected firms. Common mitigation and compliance practices include switching to renewable energy sources, improving energy efficiency, investing in clean technologies, and purchasing carbon offsets (Matsumura et al. 2014). However, companies face financial barriers in implementing effective carbon-management practices (Kannan et al. 2022). Bhatia et al. (2024) note that firm managers express concerns over budget constraints and the high costs associated with implementing digital technologies aimed at achieving carbon neutrality; for example, one manager in their study stated that financing an environmental project 'was identified as the greatest risk', adding that 'If credit financing did not work out—if I did not get a loan, it would be rather difficult for us to introduce digital technologies in order to achieve carbon neutrality' (Bhatia et al. 2024: 11).

Taken together, the cost pressures triggered by the Paris Agreement make financial flexibility increasingly important for firms seeking to meet climate mitigation requirements. As firms confront increasingly stringent climate targets, the need to reconcile compliance obligations with financial flexibility grows more acute. In this context, tax planning provides a potential channel to alleviate funding pressures and secure resources to meet climate commitments. This possibility motivates my hypothesis on how the Paris Agreement affects firms' tax planning, and the role of cost pass-through as the underlying mechanism. I elaborate on the hypothesis in the following section.

3.3. Literature Review and Hypothesis Development

Drawing on the NRBV (Hart 1995; Hart and Dowell 2011), I conceptualise carbon management as a capability that can generate long-term competitive advantage when developed and integrated into firm strategy. The NRBV emphasises that environmental strategies, such as emissions reduction, clean technology adoption and climate-ready supply chains, constitute valuable, rare, and hard-to-imitate resources (e.g. Sharma and Vredenburg 1998; Aragón-Correa and Sharma 2003; Hart and Dowell 2011). These capabilities require sustained resource commitments that function as strategic investments that enable firms to adapt to regulatory and market demands (Hart and Dowell 2011; De Stefano et al. 2016).

Building on a contingent NRBV logic, the competitive payoffs from such capabilities increase with external complexity and regulatory uncertainty, which favour proactive rather than reactive responses (Aragón-Correa and Sharma 2003).

As the world's first comprehensive climate accord, the Paris Agreement raised public awareness of climate-related risks and strengthened policymakers' commitment to stricter climate enforcement (Degryse et al. 2023). This greater level of commitment is associated with greater exposure to transition risks and increased uncertainty about future regulatory frameworks given that climate policy is sensitive to shifting public preferences, electoral cycles and the risk of late and abrupt policy changes (Campiglio et al. 2018). In this setting, firms increasingly treat carbon management as a strategic capability and incorporate carbon risk into strategic and financial decisions (Bolton and Kacperczyk 2021; Bose et al. 2021; Huang et al. 2021). Moreover, as carbon performance becomes more visible through disclosure, firms face stronger investor scrutiny and regulatory pressure, which is associated with greater investment in monitoring and abatement capabilities (Matsumura et al. 2014; Griffin et al. 2017; Downar et al. 2021; Kim et al. 2022). Thus, under the NRBV, the Paris Agreement shifted carbon management from optional initiatives to critical strategic investments and strengthened the case for allocating resources to carbon-related capabilities as a source of differentiation.

The Paris Agreement strengthens the strategic motive for firms to invest in climate-related capabilities (Degryse et al. 2023; Pang et al. 2023), but the costs of carbon management are substantial and sticky because they involve fixed commitments that are difficult to reverse and must be maintained over time (Hart and Dowell 2011; De Stefano et al. 2016; Journeault 2016). While environmental capabilities create long-term value, they also impose immediate financial pressures, consistent with the broader tension between firms' profit orientation (Friedman 1962) and costly sustainability commitments (Dhaliwal et al. 2011; Krüger 2015). Developing and maintaining these capabilities requires significant investment in abatement, reporting, and process change, and such costs have increased with tighter regulatory standards and rising investor expectations after the Paris Agreement (Pang et al. 2023). Evidence from international syndicated loans indicates that, after 2015, loan pricing reflects firms' carbon profiles more strongly and that emissions intensity enters pricing more explicitly (Ehlers et al. 2022; Degryse et al. 2023). In addition, in the post–Paris Agreement period, investors and regulators increased pressure on the quality of carbon reporting (Griffin et al. 2017; Downar et al. 2021; Kim et al. 2022), and mandated reporting imposed significant compliance and verification costs on firms (Christensen et al. 2021). Because decarbonisation programmes are investment intensive and many related costs are not quickly reversible (De Stefano et al. 2016), firms face persistent cash needs to build and sustain carbon capabilities.

The ability to shift compliance costs to stakeholders depends on market structures and the relative elasticities of demand and supply (Weyl and Fabinger 2013; for a study of energy cost pass-through in manufacturing, see also Ganapati et al. 2020). Electricity is a useful benchmark because demand is highly inelastic and market design allows rapid price adjustment in this sector. For example, in Spain's wholesale electricity market, an increase of €1 in emissions costs raised electricity prices by approximately €0.86 on average, which suggests a very high pass-through and small price-adjustment frictions in that market (Fabra and Reguant 2014). In that setting, internal adjustment is less needed precisely because firms can move costs into prices. However, most sectors face more competitive product markets and more elastic counterparties, which weakens their ability to deploy cost pass-through. Consistent with this mechanism, using as a research context private firms from Spain and the introduction of an emissions tax in 2013 in the Autonomous Community Valenciana, Jacob and Zerwer (2024) show that fixed asset investments declined in response to the emissions tax. They further show that the investment decline is unrelated to pollution intensity but is concentrated in firms operating in competitive markets, with low pricing power and limited financial flexibility.

I expect that when firms face financing needs but cost pass-through is constrained, there will be stronger incentives to rely on internal funding tools that preserve cash without disrupting core operations. One such tool is tax planning. Dyreng et al. (2022) show that when the economic burden of corporate tax falls more heavily on the firm than on workers or customers, firms engage in greater tax planning. They also find that the effect is amplified in contexts of high capital intensity, limited deductibility of capital investments, high capital productivity and stronger tax enforcement. Prior studies document that tighter financing conditions are associated with greater reliance on tax-generated cash savings, consistent with tax planning serving as an internal financing channel when external finance is costly or constrained (e.g. Atwood et al. 2012; Edwards et al. 2016).

Thus, I consider that the Paris Agreement provides an external shock that increases compliance costs and intensifies capital market attention to climate risks, pushing firms to actively manage their carbon emissions. When cost pass-through is limited by market structure and demand elasticities, firms bear a larger share of compliance costs and may need to adjust investment and financing choices internally. Exploiting this external shock, I predict a stronger association between active carbon management and tax planning,[17] particularly where firm capacity for cost pass-through is low. Thus, I present the hypothesis as follows:

Hypothesis. *After the implementation of the Paris Agreement, firms that actively manage their carbon emissions are more likely to engage in tax planning compared with those that do not.*

[17] Legitimacy theory provides an alternative perspective, suggesting that firms may avoid aggressive tax planning to align with societal expectations of corporate responsibility. From this view, paying taxes and reducing emissions can act as complements in reinforcing legitimacy (Lanis and Richardson 2015; Davis et al. 2016). Accordingly, one could expect to find the opposite pattern: firms engaging more actively in carbon management may be less likely to rely on tax planning.

3.4. Research Design

3.4.1. Sample and Data

The data are collected from several sources. I first obtain data on firms' carbon emissions through the investor survey of the CDP for the years beginning from 2011. I then merge the carbon emissions data with firms' financial data from Compustat Global and analyst coverage from the Institutional Brokers' Estimate System (I/B/E/S) database. I then obtain country-level data from the World Bank database and statutory corporate income tax rates around the world from the OECD tax database. I further collect information on carbon-pricing policies from the World Bank's Carbon Pricing Dashboard, including an indicator variable for the presence of a carbon tax and another for the existence of an ETS in each country-year. The Paris Agreement was adopted on 12 December 2015, but it officially became effective on 4 November 2016, after being ratified by enough countries to represent at least 55% of global GHG emissions.[18] Thus, this study utilises 2016 as the year of implementation, and employs the [−5, +5] year window.[19] Thus, the sample period starts in 2011 and ends in 2021.

I follow the literature and exclude firms in the financial industries (Standard Industrial Classification codes 6000–6999) because they tend to be highly regulated (Li et al. 2023). To address concerns about sample imbalance and the distinct political environment of the US,[20] I also exclude US firms, consistent with previous international studies (e.g. Zhong 2018). Furthermore, I require all firms in the DID analysis to have at least one year of data for the pre-

[18] In 2015, 195 countries and the EU signed on to the Paris Agreement.
[19] Given the Paris Agreement became effective in November 2016, results are robust to excluding this transitional year. The selection of a five-year window for analysis constitutes a deliberate trade-off, recognising that shorter periods may not fully capture the Paris Agreement's effects, whereas longer spans could be influenced by other concurrent events. The findings (untabulated) remain consistent when employing alternative timelines of three or four years before and after the implementation of the Paris Agreement.
[20] On 1 June 2017, President Donald Trump announced the US's withdrawal from the Paris Agreement. The formal withdrawal process began on 4 November 2019, and the US officially exited the agreement on 4 November 2020. On 20 January 2021, President Joe Biden signed an executive order to rejoin the Paris Agreement, with the US officially re-entering on 19 February 2021.

and post-policy periods to ensure a constant sample (Dyreng et al. 2016; Hu et al. 2023). Finally, I winsorise effective tax rates prior to being adjusted by statutory tax rates, and all other continuous variables at the 1st and 99th percentiles (Dyreng et al. 2016). These criteria leave a sample of 41,199 firm-year observations from 4,976 unique firms across 78 countries worldwide for the period 2011–2021.

Table 3.1 provides descriptive statistics of the sample distribution across year, industry and country. Panel A presents the distribution of firm-year observations by year. The number of observations increases steadily from 2,864 in 2011 (6.95%) to a peak of 4,372 in 2015 (10.61%), after which the sample remains relatively balanced across years until 2021. The period 2014–2017 accounts for nearly 41% of total observations, reflecting the years with the most complete financial and carbon disclosure coverage. Panel B reports the distribution by industry based on the Global Industry Classification Standard (GICS) two-digit classification. The largest representation comes from the industrial sector (25.84%), followed by consumer discretionary (18.66%), materials (17.28%), and consumer staples (12.32%). Together, these sectors account for more than 70% of the total firm-year observations, consistent with the concentration of firms in carbon-intensive and manufacturing-related industries. Smaller proportions are observed in information technology (9.6%), health care (6.49%), communication services (5.64%), and energy (3.41%), with utilities (0.16%) and real estate (0.6%) representing a minor share of the total observations. The total firm-year count in this panel is slightly lower than in Panels A and C because several firm-year observations have missing GICS two-digit industry codes.

Panel C presents the breakdown by country, distinguishing firms that exhibit a reduction in carbon emissions (*Emission_Reduction* = 1) from those without this reduction (*Emission_Reduction* = 0). The largest share of observations is from India (20.33%), followed by China (13.48%), the United Kingdom (4.32%), Bermuda (2.35%), and Australia (2.26%).

Countries with relatively high proportions of emissions-reducing firms include the United Kingdom, France, Finland and Switzerland. Overall, 1,957 firm-year observations (4.75% of the sample) experienced reductions in carbon emissions following the Paris Agreement. These cross-country variations in firms' emissions changes after the Paris Agreement provide the empirical basis for distinguishing the degree of exposure to the Paris Agreement in my empirical design. Because the two groups differ in sample size, I further apply entropy balancing in my robustness analysis to ensure comparability between treated and control firms. The results confirm that the findings are not driven by differences in sample composition.

Table 3.1. Sample distribution.

Panel A: Breakdown by year

Year	Firm-years	% of Total	% Cum.
2011	2,864	6.95	6.95
2012	3,126	7.59	14.54
2013	3,555	8.63	23.17
2014	4,042	9.81	32.98
2015	4,372	10.61	43.59
2016	4,301	10.44	54.03
2017	4,109	9.97	64
2018	3,983	9.67	73.67
2019	3,800	9.22	82.9
2020	3,560	8.64	91.54
2021	3,487	8.46	100
Total	41,199	100	

Panel B: Breakdown by industry

GIC2	Industry Name	Firm-years	% of Total	% Cum.
10	Energy	1,396	3.41	3.41
15	Materials	7,070	17.28	20.7
20	Industrials	10,569	25.84	46.53
25	Consumer Discretionary	7,633	18.66	65.19
30	Consumer Staples	5,041	12.32	77.51
35	Health Care	2,653	6.49	84
45	Information Technology	3,926	9.6	93.6
50	Communication Services	2,309	5.64	99.24
55	Utilities	66	0.16	99.4
60	Real Estate	244	0.6	100
Total		40,907	100	

Panel C: Breakdown by country				
Country	*Emission_Reduction* =1	*Emission_Reduction* = 0	Overall Firm-years	% of Total
United Arab Emirates	0	32	32	0.08
Argentina	0	105	105	0.25
Australia	107	826	933	2.26
Austria	0	313	313	0.76
Belgium	19	360	379	0.92
Bulgaria	0	128	128	0.31
Bermuda	0	968	968	2.35
Brazil	33	257	290	0.7
Botswana	0	18	18	0.04
Switzerland	129	512	641	1.56
Chile	0	294	294	0.71
China	10	5,543	5,553	13.48
Côte d’Ivoire	0	6	6	0.01
Colombia	0	22	22	0.05
Curaçao	0	10	10	0.02
Cayman Islands	0	2,049	2,049	4.97
Czech Republic	0	38	38	0.09
Germany	127	1,513	1,640	3.98
Denmark	76	212	288	0.7
Egypt	0	235	235	0.57
Spain	32	401	433	1.05
Estonia	0	74	74	0.18
Finland	123	408	531	1.29
France	233	1,408	1,641	3.98
United Kingdom	394	1,384	1,778	4.32
Greece	0	253	253	0.61
Hong Kong	20	388	408	0.99
Croatia	0	137	137	0.33
Hungary	11	48	59	0.14
Indonesia	0	791	791	1.92
Isle of Man	0	17	17	0.04
India	87	8,288	8,375	20.33
Ireland	31	101	132	0.32
Iceland	0	32	32	0.08
Israel	0	871	871	2.11
Italy	36	491	527	1.28
Jamaica	0	59	59	0.14
Jordan	0	125	125	0.3
Japan	0	11	11	0.03
Kazakhstan	0	81	81	0.2
Kenya	0	81	81	0.2
Sri Lanka	0	542	542	1.32
Lithuania	0	83	83	0.2
Luxembourg	0	171	171	0.42
Latvia	0	24	24	0.06
Morocco	0	59	59	0.14
Mexico	0	130	130	0.32

North Macedonia	0	10	10	0.02
Malta	0	24	24	0.06
Mauritius	0	106	106	0.26
Malaysia	0	973	973	2.36
Nigeria	0	138	138	0.33
Netherlands	89	330	419	1.02
Norway	53	201	254	0.62
New Zealand	27	199	226	0.55
Oman	0	119	119	0.29
Pakistan	0	1,208	1,208	2.93
Panama	0	10	10	0.02
Peru	0	208	208	0.5
Papua New Guinea	0	5	5	0.01
Poland	11	1,168	1,179	2.86
Portugal	22	159	181	0.44
Qatar	0	8	8	0.02
Romania	0	61	61	0.15
Russia	11	490	501	1.22
Saudi Arabia	0	9	9	0.02
Singapore	11	1,299	1,310	3.18
Serbia	0	48	48	0.12
Slovakia	0	26	26	0.06
Slovenia	0	38	38	0.09
Sweden	102	691	793	1.92
Thailand	9	556	565	1.37
Trinidad and Tobago	0	56	56	0.14
Tunisia	0	8	8	0.02
Turkey	23	377	400	0.97
Ukraine	0	8	8	0.02
Vietnam	0	361	361	0.88
South Africa	131	449	580	1.41
Total	1,957	39,242	41,199	100

Note. This table presents the sample composition. Panels A, B, and C show the distribution of the sample by year, industry, and country, respectively. "% of Total" refers to the percentage of observations in each category relative to the total number of observations in the final sample.

3.4.2. Variables and Measurement

Dependent Variables. Following previous studies on tax planning (e.g. Atwood et al. 2012; Hu et al. 2023), the primary measure of tax planning, *TAXPLAN*, is calculated based on three effective tax rate measures: *GAAP ETR*, *Cash ETR* and *ETR*. *GAAP ETR* is calculated as total tax expense divided by pre-tax-book income, *Cash ETR* as cash taxes paid divided by pre-tax-book income, and *ETR* as current tax expense divided by pre-tax-book income. Each measure is then adjusted by the relevant country's statutory corporate income tax rate. In particular, *TAXPLAN* is measured as the country's statutory corporate income tax rate minus *GAAP ETR*, *Cash ETR* and *ETR*, respectively. Because one-year measures of tax planning are highly volatile and less informative about a firm's long-term tax-planning strategy (Dyreng et al. 2008), I follow prior studies (e.g. Hu et al.2023) and sum each element in computing *TAXPLAN* over the previous two years and the current year to capture the long-term effect of carbon-management pressures arising from the Paris Agreement on corporate tax planning.

I also employ several alternative tax-planning measures, including a cash-flow-scaled measure (*Cash-flow scaled TAXPLAN*), book-tax conformity (*BTC*), and three long-term measures calculated over a five-year cumulative period based on *GAAP ETR*, *Cash ETR* and *ETR*, respectively (*Long-term TAXPLAN*). The cash-flow-scaled measure helps mitigate possible effects of changes in accounting policies that affect pre-tax-book income but not tax-planning behaviour. Following Atwood et al. (2012), I define *BTC* as the flexibility that a firm has to report taxable income that is different from pre-tax-book income in a given country-year. The five-year measure allows us to examine the sustained effect of carbon-management strategies on tax planning over a more extended period, reflecting more accurately the long-term strategic adjustments firms might make in response to tightening climate regulatory pressures. Higher values of these tax-planning measures indicate a greater degree of tax planning.

Key Explanatory Variable. The main explanatory variable used to test my hypotheses is *Post_Pressure* × *Emission_Reduction*, representing the interaction between *Post_Pressure* and *Emission_Reduction*. *Post_Pressure* is an indicator variable equal to one beginning in 2016, the year in which the Paris Agreement became effective, and zero otherwise. Following prior DID studies (e.g. Jackson et al. 2014; Wang et al. 2025), I construct *Emission_Reduction* to capture variation in firms' carbon management induced by the Agreement.[21] Firms that experience decreases in carbon emissions post–Paris Agreement are considered to be more exposed to the effects of the Agreement because such reductions likely reflect firms' active responses (e.g. investments in abatement, process improvements, or operational shifts) to climate regulatory and reputational pressures (Ramadorai and Zeni 2024). *Emission_Reduction* equals one if a firm's average carbon emissions over the five years after the Agreement are lower than the average over the five years before the Agreement, and zero otherwise.[22]

Control Variables. A set of firm- and country-level control variables are identified following the tax-planning literature (e.g. Campbell et al. 2021; Compagnie et al. 2023; Hu et al. 2023). The firm-level variables are (1) firm size (*SIZE*), measured as the natural logarithm of prior year total assets; (2) capital intensity (*PPE*), measured as property, plant, and equipment divided by prior year total assets; (3) financial leverage (*LEV*), measured as the ratio of total debt to prior year total assets; (4) intangible assets (*INTANG*) scaled by prior year total assets; (5) return on assets (*ROA*), measured as pre-tax income divided by prior year total assets; (6) inventory (*INVENTORY*), measured as inventory scaled by prior year total assets; (7) capital expenditures scaled by prior year total assets (*CAPEX*); (8) depreciation and amortisation expenses (*DEPRECIATION*), measured as depreciation expense divided by prior year total assets; (9) tax relief indicator (*TAXRELIEF*), equal to one if the firm utilises deferred tax assets to reduce current tax expense, and zero otherwise; (10) an indicator variable to capture multinational operations, equal to one if the firm reports non-zero international operating

[21] Given that the Paris Agreement itself may affect emissions, there could be a feedback loop between the Agreement and emissions. The correlation between carbon emissions reduction and tax planning might have existed even before the Paris Agreement. To mitigate this concern, I conduct a trend analysis and two placebo tests, which suggest that, prior to the Paris Agreement, there was no pre-existing trend where carbon emissions management was systematically linked to tax-planning behaviour. This indicates that the relationship I am testing (between Agreement-induced carbon emissions management and tax planning post–Paris Agreement) is likely driven by the policy intervention (the Paris Agreement) rather than by a pre-existing correlation.

[22] To assess the robustness of this identification, particularly if firms experienced substantial emissions changes in a specific year, I also employ an alternative window using three-year averages before and after the Paris Agreement. The untabulated results remain similar to my main findings.

income, and zero otherwise, because multinational firms can shift income to lower tax jurisdictions (*MULT*). At the country level, I control for *CarbonTax*, an indicator variable equal to one if a carbon tax is in effect in a given country-year, and zero otherwise;[23] *ETS*, an indicator variable equal to one if an emissions trading scheme is implemented in a given country-year, and zero otherwise; each country's tax system (*Statutory Corporate Tax Rate*); and gross domestic product growth (*GDPG*). Appendix 3.1 provides detailed definitions of all variables.

3.4.3. Model Specification

To examine whether firms' carbon management arising from the Paris Agreement is associated with changes in corporate tax planning, I estimate the following DID model:

$$TAXPLAN = \beta_0 + \beta_1\, Post\_Pressure \times Emission\_Reduction + \sum \beta_m Control\ Variables$$
$$+ \sum \beta_k Year\ fixed\ effects + \sum \beta_l Firm\ fixed\ effects + \varepsilon \qquad (1)$$

In Equation (1), *TAXPLAN* is the dependent variable calculated based on *ETR*, *GAAP ETR* and *Cash ETR* and adjusted by each country's statutory corporate income tax rate. Firms are identified as treated if they exhibit a decline in carbon emissions after 2016 relative to their pre-Agreement levels. This identification reflects firms' realised responses to post-Agreement climate pressures rather than a presumption that the Agreement itself caused emission reductions.[24] Accordingly, the estimated coefficient on *Post_Pressure* × *Emission_Reduction* captures the changes (from the pre- to post-Agreement periods) in tax planning for firms engaging in carbon management relative to the corresponding changes in tax planning for firms in the control group. Consistent with previous studies (e.g. Lel and Miller 2015), the variables

[23] Australia introduced its national carbon tax in 2012 and repealed it in 2014. The inferences remain unchanged when I exclude Australian firm-years (untabulated).

[24] This approach is conceptually consistent with prior studies that incorporate post-policy behavioural measures into their identification strategy to capture realised firm responses to regulatory changes (e.g. Wang et al. 2025).

Post_Pressure and *Emission_Reduction* become redundant because their individual main effects are absorbed by the inclusion of firm and year fixed effects.

I include year and firm fixed effects to control for the within-firm and within-year variations in firm tax planning. All standard errors are clustered at the firm level, and clustering at the country level yields similar results (untabulated). All the continuous variables are winsorised at the top and bottom one percentile to mitigate the effects of outliers.

3.5. Results Analysis

3.5.1. Main Analyses

Table 3.2 reports the summary statistics of the main variables used in my regression analyses. On average, the actions taken under Generally Accepted Accounting Principles (GAAP) by these firms (through various legal tax-planning strategies and deductions) have reduced their tax by 1.4% relative to what it would have been under the statutory tax rate, based on their earnings before tax. Similarly, when I use the broader *ETR* to calculate *TAXPLAN*, firms reduce their tax by 3.5% on average. However, on average, the *Cash ETR* is slightly above the statutory rate by approximately 2.3%. Consistent with prior studies on tax planning (e.g. Compagnie et al. 2023), the average statutory corporate income tax rate in my sample is 25.8% and displays a large standard deviation.

Table 3.2. Descriptive statistics.

VarName	Obs.	Mean	Std.	Min	P25	Median	P75	Max
TAXPLAN_GAAPETR	41,199	0.014	0.156	–0.999	–0.047	0.022	0.109	0.483
TAXPLAN_CashETR	40,248	–0.023	0.19	–1	–0.114	0	0.099	0.483
TAXPLAN_ETR	40,117	0.035	0.173	–0.992	–0.045	0.04	0.142	0.483
Cash–flow scaled TAXPLAN	38,855	0.027	0.184	–0.997	–0.063	0.05	0.138	0.483
BTC	40,254	–0.045	0.466	–37.853	–0.12	–0.001	0.099	1.162
Post_Pressure	41,199	0.564	0.496	0	0	1	1	1
Emission_Reduction	41,199	0.048	0.213	0	0	0	0	1
SIZE	41,199	22.079	2.368	13.824	20.429	21.878	23.441	28.909
PPE	41,199	0.338	0.233	0	0.155	0.299	0.483	1.36
LEV	41,199	0.131	0.152	0	0.005	0.083	0.208	0.991

INTANG	41,199	0.119	0.182	0	0.003	0.037	0.153	0.978
ROA	41,199	0.075	0.077	–1.230	0.029	0.059	0.103	0.487
INV	41,199	0.15	0.132	0	0.042	0.126	0.218	0.734
CAPEX	41,199	0.06	0.066	0	0.02	0.04	0.076	0.576
DEPRECIATION	41,199	0.04	0.027	0	0.022	0.035	0.05	0.201
TAXRELIEF	41,199	0.15	0.357	0	0	0	0	1
MULTI	41,199	0.796	0.403	0	1	1	1	1
CarbonTax	41,199	0.191	0.393	0	0	0	0	1
ETS	41,199	0.28	0.449	0	0	0	1	1
Statutory Corporate Tax Rate	41,199	0.257	0.119	0.000	0.200	0.250	0.300	0.483
GDPG	41,199	2.669	3.519	–8.034	0.828	2.734	5.568	10.103

Note. This table reports the descriptive statistics of the main testing variables. The alternative main measures, *TAXPLAN_CashETR* and *TAXPLAN_ETR*, have slightly fewer observations because the control variables are screened based on the sample used for *TAXPLAN_GAAPETR*. Two alternative dependent variables, *Cash-flow-scaled TAXPLAN* and *BTC*, are also included for reference. Their sample sizes are smaller due to missing data required for their construction. This study utilizes 2016 as the year of implementation, and employs the [−5, +5] year window. The final sample comprises 41,199 firm years from 4,976 unique firms worldwide over 2011-2021. Detailed variable definitions are provided in Appendix 3.1.

Table 3.3 reports results using three alternative measures of tax planning: *TAXPLAN_GAAPETR* in column (1), *TAXPLAN_CashETR* in column (2), and *TAXPLAN_ETR* in column (3). Consistent with my hypothesis, the coefficients on *Post_Pressure* × *Emission_Reduction* (β_1) are significantly positive across all specifications. These results are consistent with the argument that the Paris Agreement increased firms' compliance and financing pressures (Degryse et al. 2023), prompting greater reliance on tax planning as an internal source of liquidity. Under the NRBV, developing and maintaining carbon-management capabilities requires substantial and sustained investment (Hart and Dowell 2011; De Stefano et al. 2016), which can tighten cash constraints and reduce financial flexibility. In this context, firms appear to use tax planning to preserve cash flow and ease short-term financing pressures following the implementation of the Paris Agreement. Economically, these results suggest that, after controlling for firm and year fixed effects and other covariates, firms that managed their carbon emissions following the Paris Agreement increased their tax planning on average by 1.6%, 1.4% and 1.7% for *TAXPLAN_GAAPETR*, *TAXPLAN_CashETR*, *TAXPLAN_ETR*, respectively. Overall, these findings support the view that firms partially transfer the increased costs of carbon management, arising from stricter carbon targets and disclosure expectations, by lowering their effective tax contributions.

Table 3.3. The Association between Firms' Carbon Management Responses and Tax Planning Following the Paris Agreement.

VARIABLES	(1) *TAXPLAN_GAAPETR*	(2) *TAXPLAN_CashETR*	(3) *TAXPLAN_ETR*
Post_Pressure × Emission_Reduction	0.016***	0.014**	0.017**
	(2.76)	(2.18)	(2.29)
SIZE	0.011***	0.013***	–0.002
	(4.28)	(3.73)	(–0.57)
PPE	–0.016	0.021*	0.026**
	(–1.54)	(1.67)	(2.46)
LEV	0.005	–0.026**	0.002
	(0.56)	(–2.41)	(0.24)
INTANG	0.018*	0.000	0.022*
	(1.94)	(0.02)	(1.90)
ROA	0.185***	0.477***	0.288***
	(13.70)	(25.19)	(18.38)
INV	–0.026**	0.030*	–0.011
	(–2.04)	(1.70)	(–0.79)
CAPEX	0.029**	0.006	–0.001
	(2.16)	(0.35)	(–0.04)
DEPRECIATION	–0.159***	–0.434***	–0.410***
	(–2.70)	(–6.02)	(–6.37)
TAXRELIEF	0.018***	–0.005	–0.013***
	(10.03)	(–1.63)	(–5.74)
MULTI	–0.003	–0.000	–0.004
	(–1.29)	(–0.15)	(–1.30)
CarbonTax	0.005	–0.001	0.004
	(1.05)	(–0.17)	(0.79)
ETS	0.011**	0.032***	0.008*
	(2.55)	(5.07)	(1.89)
Statutory Corporate Tax Rate	0.869***	0.876***	0.898***
	(65.27)	(56.73)	(56.81)
GDPG	0.001*	0.001***	0.003***
	(1.78)	(3.00)	(6.77)
Constant	–0.462***	–0.573***	–0.179***
	(–8.21)	(–7.49)	(–2.71)
N	41,199	40,248	40,117
Adjusted R^2	0.685	0.669	0.677
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Note. This table reports regression results examining the effect of carbon management pressure on firms' tax planning following the Paris Agreement. The dependent variable is *TAXPLAN_GAAPETR* in column (1), *TAXPLAN_CashETR* in column (2), and *TAXPLAN_ETR* in column (3). The key explanatory variable, *Post_Pressure* × *Emission_Reduction*, equals one for firm-years after 2016 if the firm's average carbon emissions during the five years following the Agreement are lower than in the five years preceding it, and zero otherwise. All regressions include firm and year fixed effects, and the control variables defined in Appendix 3.1. Standard errors are clustered at the firm level. *, **, and *** represent statistical significance at the 10%, 5% and 1% level respectively based on a two-sided *t*-test.

I follow prior research (e.g. Wang et al. 2022) and perform two analyses to assess the parallel trends assumption underlying my DID approach, which assumes that the treatment and control groups exhibit similar trends in tax planning in the absence of the Paris Agreement. I first conduct a trend analysis to assess the dynamic effects of the Paris Agreement on firms' tax planning in the years surrounding the implementation of the agreement. This analysis also allows us to examine whether the effect persists over time. Specifically, I generate nine indicator variables denoting whether a given year is four or more years (*Year −4plus*), three years (*Year −3*), two years (*Year −2*), or one year (*Year −1*) before the implementation of the Paris Agreement; the year of implementation (*Year 0*); or the first year (*Year 1*), second year (*Year 2*), third year (*Year 3*), or fourth year and subsequent years (*Year 4plus*) after the implementation of the Paris Agreement. I omit *Year −1* to serve as the baseline and avoid collinearity. I then interact *Emission_Reduction* with each of the eight temporal indicator variables, rather than with just one indicator variable *Post_Pressure* as I did in my main analyses. Table 3.4 presents the dynamic effects of the Paris Agreement on firms' tax planning. Across all tax-planning measures, I find insignificant coefficients on the interaction terms between *Emission_Reduction* and the pre-Agreement indicator variables. This indicates that the observed increase in tax planning for the treatment group is unlikely due to a pre-Agreement trend.

Table 3.4. Validity of the Parallel Trend Assumption: Trend Analysis.

	(1)	(2)	(3)
VARIABLES	*TAXPLAN_GAAPETR*	*TAXPLAN_CashETR*	*TAXPLAN_ETR*
Year –4plus × Emission_Reduction	–0.008	–0.003	0.009
	(–0.90)	(–0.30)	(0.79)
Year –3 × Emission_Reduction	–0.010	–0.002	0.002
	(–1.39)	(–0.25)	(0.18)
Year –2 × Emission_Reduction	–0.005	0.005	0.008
	(–0.84)	(0.75)	(1.13)
Year 0 × Emission_Reduction	0.005	0.001	0.013
	(0.70)	(0.08)	(1.61)

Year 1 × Emission_Reduction	0.014*	0.010	0.016*
	(1.86)	(1.17)	(1.86)
Year 2 × Emission_Reduction	0.020**	0.019**	0.027***
	(2.42)	(1.97)	(2.80)
Year 3 × Emission_Reduction	0.014	0.030***	0.037***
	(1.38)	(2.94)	(3.80)
Year 4plus × Emission_Reduction	0.002	0.009	0.019*
	(0.22)	(0.81)	(1.77)
SIZE	0.011***	0.013***	–0.002
	(4.27)	(3.75)	(–0.55)
PPE	–0.016	0.020*	0.026**
	(–1.54)	(1.65)	(2.45)
LEV	0.005	–0.026**	0.002
	(0.58)	(–2.41)	(0.24)
INTANG	0.018*	0.000	0.022*
	(1.93)	(0.02)	(1.89)
ROA	0.185***	0.476***	0.288***
	(13.70)	(25.16)	(18.34)
INV	–0.026**	0.030*	–0.011
	(–2.04)	(1.68)	(–0.80)
CAPEX	0.029**	0.006	–0.000
	(2.16)	(0.35)	(–0.02)
DEPRECIATION	–0.159***	–0.434***	–0.410***
	(–2.70)	(–6.02)	(–6.37)
TAXRELIEF	0.018***	–0.005	–0.013***
	(10.02)	(–1.63)	(–5.72)
MULTI	–0.003	–0.001	–0.004
	(–1.28)	(–0.15)	(–1.30)
CarbonTax	0.005	–0.001	0.004
	(1.03)	(–0.22)	(0.81)
ETS	0.011**	0.032***	0.008*
	(2.50)	(5.05)	(1.87)
Statutory Corporate Tax Rate	0.871***	0.877***	0.898***
	(65.32)	(56.62)	(56.76)
GDPG	0.001*	0.001***	0.003***
	(1.80)	(2.97)	(6.73)
Constant	–0.462***	–0.575***	–0.181***
	(–8.19)	(–7.49)	(–2.73)
N	41,199	40,248	40,117
Adjusted R^2	0.685	0.669	0.677
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Note. This table reports the results of the trend analysis used to assess the validity of the parallel trends assumption underlying the DID design. *Year -4plus* to *Year 4plus* are indicator variables equal to one for each year relative to the implementation of the Paris Agreement (*Year 0*) and zero otherwise. *Year -4plus* captures the fourth year and earlier prior to implementation; *Year -3*, *Year -2*, and *Year -1* capture the third, second, and first pre-implementation years, respectively; *Year 1* to *Year 3* capture the first to third post-implementation years; and *Year 4plus* captures the fourth and subsequent post-implementation years. *Year -1* is omitted as the reference year. Standard errors are clustered at the firm-level and are reported between parentheses. *, **, and *** represent statistical significance at the 10%, 5% and 1% level respectively based on a two-sided *t*-test. All of the variables are defined in Appendix 3.1.

In my second analysis, I conduct falsification tests to further assess the parallel-trends assumption. In the first (second) placebo test, I restrict the sample to the pre-Agreement periods and set a pseudo-reform year as three (two) years prior to the actual start of the Paris Agreement, corresponding to 2013 (2014). I then define indicator variables *After agreement_Pseudo1* (*After agreement_Pseudo2*) to identify the years following these pseudo-reform years. Table 3.5 presents the results. Across all specifications, the coefficients on *After_agreement_Pseudo1* × *Emission_Reduction* and *After_agreement_Pseudo2* × *Emission_Reduction* are statistically insignificant at conventional levels. This indicates that the estimated treatment effect in my main analysis is unlikely to be driven by spurious correlations or pre-existing differences in tax-planning trends between treatment and control firms. Overall, the falsification results corroborate the validity of the parallel-trends assumption underlying the DID design.

Table 3.5. Validity of the Parallel Trend Assumption: Placebo Regressions.

	Pseudo–Reform Year 2013			Pseudo–Reform Year 2014		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*TAXPLAN_GAAPETR*	*TAXPLAN_CashETR*	*TAXPLAN_ETR*	*TAXPLAN_GAAPETR*	*TAXPLAN_CashETR*	*TAXPLAN_ETR*
After_agreement_Pseudo1 × Emission_Reduction	0.004	0.004	–0.001			
	(0.55)	(0.44)	(–0.14)			
After_agreement_Pseudo2 × Emission_Reduction				0.004	0.005	0.001
				(0.66)	(0.73)	(0.11)
SIZE	0.007**	0.008	–0.002	0.007**	0.008	–0.002
	(1.99)	(1.39)	(–0.43)	(1.99)	(1.39)	(–0.42)
PPE	0.012	0.044**	0.062***	0.012	0.044**	0.062***
	(0.79)	(2.44)	(3.75)	(0.78)	(2.44)	(3.75)
LEV	–0.011	–0.069***	–0.020	–0.011	–0.069***	–0.020
	(–0.87)	(–4.27)	(–1.30)	(–0.87)	(–4.27)	(–1.30)
INTANG	0.015	0.009	0.011	0.015	0.009	0.011
	(1.11)	(0.49)	(0.74)	(1.10)	(0.49)	(0.74)
ROA	0.140***	0.370***	0.217***	0.140***	0.370***	0.217***
	(6.41)	(12.19)	(9.33)	(6.41)	(12.19)	(9.34)
INV	–0.037**	0.008	–0.025	–0.037**	0.008	–0.026
	(–1.97)	(0.30)	(–1.22)	(–1.97)	(0.30)	(–1.23)
CAPEX	0.002	0.009	–0.037*	0.002	0.009	–0.037*
	(0.10)	(0.41)	(–1.91)	(0.11)	(0.42)	(–1.91)
DEPRECIATION	–0.220**	–0.506***	–0.526***	–0.219**	–0.505***	–0.526***
	(–2.47)	(–5.13)	(–5.22)	(–2.47)	(–5.12)	(–5.22)
TAXRELIEF	0.015***	0.002	–0.001	0.015***	0.002	–0.001
	(5.05)	(0.63)	(–0.24)	(5.07)	(0.64)	(–0.24)
MULTI	–0.001	–0.002	0.000	–0.001	–0.002	0.000
	(–0.33)	(–0.49)	(0.07)	(–0.32)	(–0.48)	(0.07)

CarbonTax	0.010**	–0.003	–0.002	0.010**	–0.003	–0.002
	(2.06)	(–0.52)	(–0.37)	(2.06)	(–0.55)	(–0.40)
ETS	0.014	0.013	0.002	0.014	0.013	0.002
	(0.81)	(0.59)	(0.11)	(0.81)	(0.59)	(0.12)
Statutory Corporate Tax Rate	0.946***	0.902***	0.960***	0.946***	0.902***	0.961***
	(49.16)	(39.87)	(40.77)	(49.30)	(39.99)	(40.91)
GDPG	0.000	0.001	0.002***	0.000	0.001	0.002***
	(0.26)	(1.49)	(3.09)	(0.26)	(1.48)	(3.08)
Constant	–0.396***	–0.437***	–0.174*	–0.396***	–0.439***	–0.176*
	(–5.06)	(–3.58)	(–1.72)	(–5.06)	(–3.59)	(–1.73)
N	17,374	16,814	15,705	17,374	16,814	15,705
Adjusted R^2	0.770	0.762	0.768	0.770	0.762	0.768
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes

Note. This table reports placebo test results using pseudo adoption years in the pre-agreement period. *After_agreement_Pseudo1* (*After_agreement_Pseudo2*) equals one if a given year is the year following the pseudo-agreement year (that is, three or two years, respectively, before the actual implementation year), and zero otherwise. Standard errors are clustered at the firm level and are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, based on two-sided *t*-tests. All variable definitions are provided in Appendix 3.1.

3.5.2. Supplementary Analyses

The main findings show that firms increase tax planning in response to the cost pressures of carbon emissions management following the Paris Agreement. This section examines the mechanisms underlying this relationship and the heterogeneity across firms and legal systems. I first investigate whether pre-existing tax-planning experience explains variation in firms' post-Agreement responses. I then analyse how firm characteristics related to market competition, pricing power and financial flexibility affect the extent to which firms rely on tax planning to absorb abatement and compliance costs. Finally, I examine how governance factors (agency costs and analyst coverage) and legal origin are associated with firms' tax-planning responses to the Paris Agreement.

3.5.2.1. Pre-Agreement Tax Planning Heterogeneity

To further examine heterogeneity in firms' responses, I partition the sample based on pre-Agreement tax-planning behaviour. Firms are classified as aggressive (non-aggressive) tax planners if their average *TAXPLAN* during the pre-Agreement period falls within the top 25% (bottom 25%) of the distribution, and firms in the middle range are excluded. Across all three outcome measures, I find that the Paris Agreement's effect on tax planning is more pronounced among firms with a history of aggressive tax strategies, as reported in Table 3.6. These firms likely possess the expertise and organisational flexibility to further optimise tax planning in response to the increased financial pressures imposed by the Agreement. In contrast, the effect is weaker and statistically insignificant for non-aggressive planners, consistent with their limited tax-planning capability and lower flexibility to reallocate resources under increased financial pressure following the Paris Agreement. The full set of estimated coefficients differs jointly across the two subsamples.

Table 3.6. Pre-Agreement Tax Planning Heterogeneity.

	Aggressive Tax Planners	Non–Aggressive Tax Planners	Aggressive Tax Planners	Non–Aggressive Tax Planners	Aggressive Tax Planners	Non–Aggressive Tax Planners
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*TAXPLAN_GAAPETR*		*TAXPLAN_CashETR*		*TAXPLAN_ETR*	
Post_Pressure × Emission_Reduction	0.029***	0.016	0.029*	0.001	0.044**	0.006
	(2.64)	(1.14)	(1.89)	(0.06)	(2.49)	(0.26)
SIZE	0.021***	0.005	0.019***	–0.004	0.012*	–0.005
	(3.33)	(0.97)	(2.75)	(–0.62)	(1.87)	(–0.82)
PPE	–0.036*	–0.019	–0.008	0.014	0.014	0.022
	(–1.90)	(–0.66)	(–0.37)	(0.44)	(0.69)	(0.78)
LEV	0.037*	–0.006	–0.012	–0.038	0.028	–0.013
	(1.91)	(–0.28)	(–0.50)	(–1.60)	(1.22)	(–0.58)
INTANG	0.020	0.023	–0.017	0.072**	0.011	0.043
	(1.15)	(0.84)	(–0.76)	(2.31)	(0.58)	(1.27)
ROA	0.072***	0.435***	0.369***	0.702***	0.162***	0.525***
	(3.33)	(11.92)	(12.88)	(15.16)	(6.92)	(12.63)
INV	–0.051***	–0.016	0.027	0.028	–0.024	0.034
	(–2.89)	(–0.42)	(0.89)	(0.61)	(–1.04)	(0.78)
CAPEX	0.012	0.104*	0.025	0.016	–0.033	0.020
	(0.55)	(1.96)	(0.96)	(0.31)	(–1.53)	(0.41)
DEPRECIATION	–0.187*	–0.444***	–0.345**	–0.619***	–0.369***	–0.594***
	(–1.65)	(–2.89)	(–2.45)	(–3.74)	(–2.88)	(–3.83)
TAXRELIEF	0.015***	0.033***	–0.008	–0.006	–0.012***	–0.010
	(4.13)	(5.41)	(–1.35)	(–0.85)	(–2.97)	(–1.41)
MULTI	–0.003	–0.012*	–0.007	–0.010	0.001	–0.002
	(–0.80)	(–1.76)	(–1.26)	(–1.33)	(0.10)	(–0.24)
CarbonTax	–0.018*	0.014	–0.013	0.011	–0.010	0.008
	(–1.84)	(0.99)	(–1.12)	(0.83)	(–0.87)	(0.59)
ETS	0.014	0.006	0.035**	–0.001	0.020*	–0.003
	(1.56)	(0.27)	(2.42)	(–0.04)	(1.96)	(–0.12)
Statutory Corporate Tax Rate	0.842***	0.887***	0.840***	0.881***	0.847***	0.943***
	(29.17)	(25.07)	(26.81)	(23.34)	(30.57)	(23.17)
GDPG	0.002**	–0.002	0.003***	–0.001	0.004***	0.002
	(2.07)	(–1.60)	(3.34)	(–0.57)	(5.69)	(1.43)
Constant	–0.625***	–0.390***	–0.667***	–0.213*	–0.428***	–0.167

	(–4.37)	(–3.65)	(–4.22)	(–1.65)	(–3.01)	(–1.21)
N	10,303	9,940	10,286	9,669	10,214	9,496
Adjusted R^2	0.589	0.457	0.671	0.504	0.635	0.541
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Test for equality of coefficients (Aggressive vs. Non–Aggressive):	$p < 0.001$		$p < 0.001$		$p < 0.001$	

Note. This table presents regression results examining whether the association between emission reduction and tax planning after the Paris Agreement differs by firms' pre-agreement tax planning behavior. Firms are classified as aggressive (non-aggressive) tax planners if their average *TAXPLAN* during the pre-agreement period falls within the top 25% (bottom 25%) of the distribution. Firms in the middle range are excluded. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, based on two-sided *t*-tests. All variable definitions are provided in Appendix 3.1.

3.5.2.2. Role of Market Structure

I examine whether market structure moderates firms' tax-planning responses to carbon-management pressure after the Paris Agreement. A firm's ability to pass compliance costs to prices depends on market power and demand elasticities: price-takers in competitive markets face tighter pass-through constraints, whereas price-setters in concentrated markets can adjust prices and contract terms more easily (Weyl and Fabinger 2013; for evidence on high cost pass-through in electricity markets, see also Fabra and Reguant 2014; and for evidence about investment contractions under an emissions levy when pricing power is limited, see Jacob and Zerwer 2024). When pass-through is constrained, firms are more likely to rely on internal financing tools such as tax planning to preserve cash.

I proxy competition with sales-based Herfindahl–Hirschman Index (*HHI*), where higher *HHI* indicates greater concentration and therefore weaker competition. For each country-industry-year, *HHI* equals the sum of squared sales shares of firms. To avoid mechanical effects of the Agreement on market structure, I compute the pre-Agreement (2011–2015) average *HHI* and classify observations into High-competition (Low *HHI*) and Low-competition (High *HHI*) groups using the median of the pre-Agreement HHI distribution. Results are similar when I use alternative cutoffs such as quartiles or aggregate HHI at a broader industry level (untabulated). Table 3.7 reports the estimates. The coefficient on *Post_Pressure* × *Reduced Carbon Emissions* is positive and statistically significant in the High-competition subsample, but insignificant in the Low-competition subsample across all three tax-planning measures). The test for equality of coefficients rejects the null at $p < 0.001$ for each measure, indicating a statistically significant difference between the two groups. These results are consistent with the limited cost pass-through mechanism, whereby stronger competition constrains firms' ability to shift compliance costs to customers, increases the share of costs borne by the firm, and amplifies reliance on tax planning to generate cash savings.

3.5.2.3. Variation in Pricing Power

I next examine whether firms' pricing power influences the extent to which they adjust tax planning in response to carbon-management pressure arising from the Paris Agreement. Pricing power influences a firm's ability to pass compliance costs to customers (Jacob and Zerwer 2024); firms with weaker pricing power are expected to absorb a larger share of these costs internally and therefore rely more on tax planning to preserve cash.

I first use operating profit margin to proxy firm-level pricing power, which is closely related to the ability to pass on compliance costs to customers (Jacob and Zerwer 2024). Firms with lower margins face tighter constraints on cost pass-through and have fewer internal resources to absorb higher carbon-management costs, so I expect them to rely more on tax planning to preserve cash. Following Compagnie et al. (2023), I split the sample using the three-year average operating profit margin computed over the pre-Agreement period. I classify observations into Low-margin and High-margin groups using the sample median; results are similar with quartile cutoffs (untabulated). Table 3.8, Panel A shows that the coefficient on *Post_Pressure* × *Reduced Carbon Emissions* is positive and statistically significant for the Low-margin group across all three tax-planning measures, while the effect for the High-margin group is smaller and generally weaker. For *TAXPLAN_GAAPETR*, the coefficient is positive and significant for both low- and high-margin firms, but the estimated effect is both economically larger and statistically more significant for low-margin firms. For *TAXPLAN_CashETR* and *TAXPLAN_ETR*, the coefficient is positive and significant only for low-margin firms, and insignificant for high-margin firms. The test for equality of coefficients rejects the null at conventional levels, indicating that firms with weaker pricing power exhibit stronger tax-planning adjustments after the Paris Agreement.

I also examine differences in cost pass-through capacity by consumer orientation. Prior evidence reveals that retailers (i.e. firms selling primarily to end consumers) pass-through idiosyncratic cost shocks more slowly and less completely than other firms (e.g. Alvarez-Blaser et al. 2025). Accordingly, I expect that business-to-consumer (*B2C*) firms, which face more elastic demand and have less ability to shift compliance costs to customers, to exhibit stronger tax-planning adjustments after the Paris Agreement. Following Eccles et al. (2014),[25] I classify firms into *B2C* and others based on Standard Industrial Classification (SIC) code ranges. Table 3.8, Panel B shows that the coefficient on *Post_Pressure* × *Reduced Carbon Emissions* is positive and statistically significant for *B2C* firms, but not significant for other firms. The full set of estimated coefficients differs jointly across the two groups.

These results on pricing power are consistent with the pass-through channel. When firms face more elastic demand and have less pricing power, they rely more on tax planning to meet their financing needs associated with carbon-management activities.[26]

[25] The following four-digit SIC codes are assigned to the consumer goods group: 0000–0999, 2000–2399, 2500–2599, 2700–2799, 2830–2869, 3000–3219, 3420–3429, 3523, 3600–3669, 3700–3719, 3751, 3850–3879, 3880–3999, 4813, 4830–4899, 5000–5079, 5090–5099, 5130–5159, 5220–5999, 7000–7299, 7400–9999.

[26] An alternative interpretation of the results in Sections 3.5.2.2 and 3.5.2.3 is that firms in competitive markets or with lower pricing power are more financially constrained in general, such that any cost shock, not necessarily related to carbon management, would trigger greater tax-planning activity. While this channel cannot be fully ruled out, the interaction term *Post_Pressure* × *Emission_Reduction* conditions the effect specifically on firms that actively reduce emissions following the Paris Agreement, making it less likely that the results merely capture a generalised financial distress response unrelated to climate pressure. Nevertheless, I acknowledge that cost-shock sensitivity and carbon-specific financing needs may be difficult to disentangle empirically.

Table 3.7. Role of Market Structure.

	Low Competition	High Competition	Low Competition	High	Low Competition	High Competition
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*TAXPLAN_GAAPETR*		*TAXPLAN_CashETR*		*TAXPLAN_ETR*	
Post_Pressure × Emission_Reduction	0.008	0.012**	0.010	0.016*	0.015	0.017*
	(0.84)	(2.15)	(1.08)	(1.96)	(1.30)	(1.80)
SIZE	0.000	0.014***	0.013**	0.013***	–0.006	0.002
	(–0.38)	(6.77)	(2.48)	(2.82)	(–1.34)	(0.50)
PPE	–0.007	–0.007	0.007	0.037**	0.030**	0.023
	(–0.70)	(–0.71)	(0.40)	(2.07)	(2.09)	(1.45)
LEV	–0.014	0.021**	–0.024	–0.029*	–0.003	0.011
	(–1.09)	(2.35)	(–1.62)	(–1.78)	(–0.25)	(0.74)
INTANG	0.029***	0.020**	–0.019	0.016	0.015	0.026*
	（2.61）	(2.17)	(–1.04)	(0.99)	(0.83)	(1.75)
ROA	0.272***	0.166***	0.484***	0.471***	0.294***	0.285***
	(11.98)	(13.59)	(18.77)	(17.09)	(13.56)	(12.61)
INV	–0.035***	–0.026**	0.044*	0.016	0.011	–0.033*
	(–2.66)	(–2.13)	(1.81)	(0.61)	(0.57)	(–1.67)
CAPEX	0.112***	0.002	0.027	–0.017	0.010	–0.013
	(5.42)	(0.13)	(1.15)	(–0.69)	(0.50)	(–0.64)
DEPRECIATION	–0.201***	–0.249***	–0.394***	–0.476***	–0.420***	–0.394***
	(–3.21)	(–4.38)	(–3.78)	(–4.82)	(–4.60)	(–4.41)
TAXRELIEF	0.038***	0.018***	–0.002	–0.007*	–0.011***	–0.015***
	(12.16)	(7.09)	(–0.42)	(–1.92)	(–3.34)	(–4.79)
MULTI	–0.006	–0.003	–0.003	0.003	–0.006	–0.002
	(–1.61)	(–0.96)	(–0.74)	(0.53)	(–1.37)	(–0.44)
CarbonTax	0.021***	–0.007*	0.000	–0.002	0.007	0.000
	(4.26)	(–1.78)	(0.05)	(–0.35)	(1.00)	(0.06)
ETS	–0.001	0.010*	0.029***	0.035***	0.012**	0.005
	(–0.14)	(1.84)	(3.16)	(3.96)	(2.01)	(0.80)
Statutory Corporate Tax Rate	0.764***	0.866***	0.876***	0.877***	0.914***	0.883***

	(46.37)	(58.54)	(39.87)	(40.13)	(40.27)	(39.94)
GDPG	0.006***	0.001*	0.002**	0.001*	0.003***	0.003***
	(11.73)	(1.83)	(2.37)	(1.84)	(4.57)	(5.01)
Constant	–0.211***	–0.523***	–0.559***	–0.586***	–0.089	–0.255***
	(–12.10)	(–11.54)	(–4.99)	(–5.66)	(–0.90)	(–3.06)
N	20544	20,624	20,095	20,153	19,966	20,151
Adjusted R^2	0.639	0.691	0.667	0.672	0.668	0.685
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Test for equality of coefficients (High vs. Low):	$p < 0.001$		$p < 0.001$		$p < 0.001$	

Note. This table presents regression results examining whether product-market competition moderates the association between emission reduction and tax planning after the Paris Agreement. Industry concentration is measured by the sales-based *HHI*, averaged over 2011-2015. Observations are classified into High-Competition (Low *HHI*) and Low-Competition (High *HHI*) groups based on the median pre-Agreement *HHI*. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-sided *t*-tests. Variable definitions appear in Appendix 3.1.

Table 3.8. Variation in Pricing Power.

Panel A. Profit margin

	LOW Profit Margin	HIGH Profit Margin	LOW Profit Margin	HIGH Profit Margin	LOW Profit Margin	HIGH Profit Margin
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*TAXPLAN_GAAPETR*		*TAXPLAN_CashETR*		*TAXPLAN_ETR*	
Post_Pressure × Emission_Reduction	0.022**	0.012*	0.023**	0.008	0.023*	0.014
	(2.23)	(1.70)	(2.27)	(1.05)	(1.91)	(1.57)
SIZE	0.013***	0.009***	0.007	0.015***	–0.005	–0.000
	(2.81)	(2.97)	(1.17)	(3.54)	(–1.04)	(–0.04)
PPE	–0.024	–0.010	0.029	0.018	0.044**	0.019
	(–1.39)	(–0.79)	(1.25)	(1.28)	(2.28)	(1.50)
LEV	0.020	–0.001	–0.004	–0.034***	–0.000	0.007
	(1.17)	(–0.08)	(–0.20)	(–2.65)	(–0.02)	(0.62)
INTANG	0.019	0.015	–0.014	0.006	0.027	0.015
	(1.11)	(1.40)	(–0.66)	(0.45)	(1.29)	(1.14)
ROA	0.275***	0.132***	0.621***	0.397***	0.426***	0.207***
	(11.04)	(8.27)	(17.28)	(17.70)	(15.61)	(11.08)
INV	–0.013	–0.056***	0.101***	–0.079***	0.020	–0.068***
	(–0.70)	(–3.33)	(4.17)	(–3.18)	(0.98)	(–3.62)
CAPEX	0.049**	0.019	–0.005	0.014	–0.013	0.007
	(2.17)	(1.14)	(–0.16)	(0.68)	(–0.50)	(0.39)
DEPRECIATION	–0.253**	–0.054	–0.571***	–0.276***	–0.647***	–0.211***
	(–2.46)	(–0.79)	(–4.60)	(–3.14)	(–5.97)	(–2.68)
TAXRELIEF	0.027***	0.012***	–0.002	–0.007**	–0.012***	–0.014***
	(8.10)	(5.75)	(–0.38)	(–2.07)	(–3.28)	(–5.07)
MULTI	–0.002	–0.004	0.002	–0.004	–0.004	–0.004
	(–0.61)	(–1.34)	(0.47)	(–0.86)	(–0.86)	(–1.12)
CarbonTax	0.005	0.005	–0.003	0.003	–0.000	0.011
	(0.76)	(0.84)	(–0.45)	(0.55)	(–0.05)	(1.59)
ETS	0.008	0.013***	0.021*	0.036***	0.014*	0.005
	(0.92)	(2.79)	(1.80)	(4.66)	(1.93)	(0.88)

Statutory Corporate Tax Rate	0.870***	0.871***	0.884***	0.868***	0.908***	0.892***
	(42.78)	(51.61)	(37.72)	(44.16)	(39.21)	(41.84)
GDPG	0.000	0.001*	0.001*	0.001**	0.003***	0.003***
	(0.84)	(1.72)	(1.73)	(2.51)	(4.44)	(5.21)
Constant	–0.510***	–0.407***	–0.447***	–0.614***	–0.124	–0.196**
	(–5.22)	(–6.08)	(–3.68)	(–6.37)	(–1.12)	(–2.38)
N	19,799	21,400	19,310	20,938	19,341	20,776
Adjusted R^2	0.651	0.723	0.627	0.716	0.658	0.699
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Test for equality of coefficients (High vs. Low):	$p < 0.001$		$p < 0.001$		$p < 0.001$	

Panel B. Sales type (B2C vs. Others)

	B2C	Other	B2C	Other	B2C	Other
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*TAXPLAN_GAAPETR*		*TAXPLAN_CashETR*		*TAXPLAN_ETR*	
Post_Pressure × Emission_Reduction	0.021***	0.012	0.020**	0.008	0.031**	0.004
	(2.59)	(1.44)	(2.04)	(0.94)	(2.57)	(0.50)
SIZE	0.014***	0.009**	0.018***	0.009*	0.003	–0.007*
	(3.88)	(2.35)	(3.54)	(1.91)	(0.74)	(–1.77)
PPE	–0.011	–0.021	0.013	0.027	0.040***	0.013
	(–0.74)	(–1.44)	(0.78)	(1.54)	(2.67)	(0.87)
LEV	0.006	0.004	–0.029*	–0.026	–0.017	0.023
	(0.47)	(0.33)	(–1.95)	(–1.58)	(–1.20)	(1.57)
INTANG	0.013	0.022*	–0.006	0.008	0.032*	0.014
	(0.97)	(1.74)	(–0.41)	(0.42)	(1.80)	(0.86)
ROA	0.184***	0.185***	0.441***	0.513***	0.275***	0.297***
	(9.70)	(9.74)	(16.10)	(20.50)	(12.08)	(13.89)
INV	–0.013	–0.038**	0.043*	0.016	–0.012	–0.012
	(–0.77)	(–1.99)	(1.96)	(0.59)	(–0.63)	(–0.59)
CAPEX	0.013	0.044**	0.004	0.008	–0.015	0.011
	(0.66)	(2.42)	(0.17)	(0.33)	(–0.79)	(0.54)
DEPRECIATION	–0.190**	–0.132	–0.326***	–0.556***	–0.436***	–0.375***

	(–2.25)	(–1.62)	(–3.03)	(–5.84)	(–4.51)	(–4.38)
TAXRELIEF	0.018***	0.019***	–0.007*	–0.003	–0.012***	–0.013***
	(6.94)	(7.27)	(–1.74)	(–0.67)	(–3.96)	(–4.26)
MULTI	–0.003	–0.003	–0.004	0.003	–0.003	–0.005
	(–0.93)	(–0.94)	(–0.84)	(0.54)	(–0.76)	(–1.16)
CarbonTax	0.009	0.000	0.004	–0.005	0.008	0.001
	(1.45)	(0.08)	(0.52)	(–0.72)	(1.00)	(0.16)
ETS	0.002	0.017***	0.026***	0.038***	0.001	0.014**
	(0.29)	(3.55)	(2.69)	(4.52)	(0.16)	(2.44)
Statutory Corporate Tax Rate	0.861***	0.877***	0.887***	0.865***	0.921***	0.875***
	(44.51)	(47.74)	(39.57)	(40.69)	(39.42)	(41.09)
GDPG	0.002***	–0.000	0.002**	0.001*	0.003***	0.003***
	(3.15)	(–0.58)	(2.55)	(1.66)	(4.93)	(4.52)
Constant	–0.520***	–0.408***	–0.675***	–0.488***	–0.300***	–0.065
	(–6.81)	(–5.06)	(–6.20)	(–4.62)	(–2.96)	(–0.80)
N	20,363	20,836	19,900	20,348	19,743	20,374
Adjusted R2	0.696	0.673	0.678	0.661	0.682	0.672
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Test for equality of coefficients (High vs. Low):	$p < 0.001$		$p < 0.001$		$p < 0.001$	

Note. This table presents regression results examining whether firms' pricing power moderates the association between emission reduction and tax planning following the Paris Agreement. In Panel A, pricing power is proxied by the *Profit Margin* averaged over the pre-Agreement period (2011-2015). Observations are classified into Low-margin and High-margin groups based on the sample median. In Panel B, firms are classified as B2C or Other based on their SIC codes following Eccles et al. (2014). Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-sided *t*-tests. Variable definitions appear in Appendix 3.1.

3.5.2.4. Variation in Financial Flexibility

I examine whether differences in financial flexibility, interpreted as differences in the elasticity of firms' demand for capital, shape the tax-planning response to carbon-management pressure. In the context of carbon-management pressure, firms with greater financial flexibility are expected to adjust investments related to carbon management and financing decisions more efficiently and thus bear a smaller share of compliance costs internally, whereas financially constrained firms are less able to adjust and therefore carry more of the burden, consistent with prior evidence that financial flexibility affects firms' ability to absorb cost shocks and pass them through to prices (Weyl and Fabinger 2013; Jacob and Zerwer 2024). Financial flexibility is defined as 'the ability of a firm to access and restructure its financing at a low cost' (Gamba and Triantis 2008: 2263). A basic form of flexibility relates to the resources a firm can draw on in the future. Following Choi et al. (2021), I proxy financial flexibility inversely by financing constraints.

I use two standard measures of financing constraints, the Kaplan–Zingales (KZ) and Whited–Wu (WW) indices. Kaplan and Zingales (1997) show that estimated cash-flow sensitivities are greatest among firms that are least constrained. Building on this idea, Lamont et al. (2001) construct the *KZ index* using five accounting-based variables (i.e. cash flow, market-to-book ratio, leverage, dividends and cash holdings), each scaled by lagged property, plant and equipment or total assets. The index is estimated using an ordered logit model that maps these components into an ordinal ranking of financial constraints. The *KZ index* loads positively on market-to-book and leverage, and negatively on cash flow, dividends and cash holdings. Thus, a higher *KZ index* indicates greater financing constraints.

Whited and Wu (2006) develop the *WW index* from a structural investment model to capture firm-level financing frictions. The index uses six variables: cash flow; a dividend-payer indicator; long-term debt; firm size (log of total assets); industry sales growth; and firm sales growth. The *WW index* loads negatively on cash flow, the dividend-payer indicator, and firm size and positively on long-term debt and industry sales growth, but negatively on firm sales growth. A higher *WW index* likewise indicates more severe external-finance constraints and therefore lower financial flexibility. For each index, I compute the firm-level average over the pre-Agreement period and classify a firm as constrained if this average is above the sample median for that index, and unconstrained otherwise. This pre-period split avoids post-treatment contamination.

Table 3.9 reports the results. Using the *KZ index* (columns (1)–(6)), the coefficients on *Post_Pressure* × *Reduced Carbon Emissions* are positive and statistically significant for constrained firms across all three measures, but insignificant and close to zero for unconstrained firms. The *WW index* produces similar results (columns (7)–(12)): the coefficients for constrained firms are positive and statistically significant, whereas the corresponding estimates for unconstrained firms are insignificant. In all specifications, the full set of estimated coefficients differs jointly between constrained and unconstrained firms ($p < 0.001$). Taken together, these results indicate that firms facing tighter financing conditions exhibit stronger post-Agreement increases in tax planning. This finding is consistent with the view that financing constraints limit the ability to raise external funds for compliance and carbon-management investments, which strengthens the incentive to use tax planning as an internal source of funds.

Table 3.9. Variation in Financial Flexibility.

Panel A. KZ index

	Unconstrained_KZ	Constrained_KZ	Unconstrained_KZ	Constrained_KZ	Unconstrained_KZ	Constrained_KZ
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*TAXPLAN_GAAPETR*		*TAXPLAN_CashETR*		*TAXPLAN_ETR*	
Post_Pressure × Emission_Reduction	0.002	0.022***	0.001	0.020***	0.008	0.018**
	(0.23)	(3.45)	(0.06)	(2.77)	(0.71)	(2.10)
PPE	–0.030	–0.008	–0.000	0.055**	0.044**	0.000
	(–1.64)	(–0.48)	(–0.02)	(2.52)	(2.51)	(0.00)
LEV	0.032*	0.012	0.030	-0.040***	0.014	-0.003
	(1.91)	(0.90)	(1.53)	(-2.77)	(0.78)	(-0.21)
INTANG	0.034	0.006	–0.021	0.038**	0.037	0.026
	(1.55)	(0.50)	(–0.774)	(2.51)	(1.50)	(1.54)
ROA	0.328***	0.109***	0.634***	0.415***	0.414***	0.227***
	(11.68)	(5.66)	(17.497)	(14.94)	(13.59)	(9.81)
INV	–0.020	–0.023	0.107***	-0.006	0.013	-0.011
	(–0.78)	(–1.14)	(3.049)	(-0.26)	(0.48)	(-0.48)
CAPEX	0.048*	0.008	0.010	-0.027	-0.008	0.030
	(1.91)	(0.35)	(0.341)	(-0.99)	(-0.31)	(1.06)
DEPRECIATION	–0.225*	–0.114	–0.372***	-0.467***	-0.612***	-0.299***
	(–1.78)	(–1.33)	(–2.647)	(-4.28)	(-4.82)	(-2.88)
TAXRELIEF	0.026***	0.021***	–0.002	-0.010**	-0.011**	-0.012***
	(5.42)	(6.70)	(–0.393)	(-2.54)	(-2.09)	(-3.29)
MULTI	–0.004	–0.004	0.003	-0.007	0.005	-0.005
	(–0.76)	(–1.15)	(0.507)	(-1.49)	(0.86)	(-1.23)
CarbonTax	0.007	0.002	–0.003	0.003	0.009	-0.001
	(0.92)	(0.33)	(–0.361)	(0.51)	(1.10)	(-0.21)
ETS	–0.006	–0.003	–0.011	-0.027**	0.011	-0.008
	(–0.41)	(–0.29)	(–0.757)	(-2.20)	(0.99)	(-0.82)
Statutory Corporate Tax Rate	0.893***	0.830***	0.893***	0.826***	0.972***	0.838***
	(39.16)	(48.43)	(35.307)	(40.49)	(38.54)	(39.53)
GDPG	0.002***	–0.001	0.002***	0.000	0.004***	0.001*
	(2.68)	(–1.44)	(2.588)	(0.60)	(6.32)	(1.69)
Constant	–0.195**	–0.384***	–0.063	-0.399***	-0.088	-0.178
	(–2.01)	(–4.20)	(–0.527)	(-3.38)	(-0.79)	(-1.45)

N	16,068	16,737	15,726	16,612	15,741	16,201
Adjusted R^2	0.636	0.736	0.602	0.673	0.666	0.699
Year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Test for equality of coefficients (Constrained vs Unconstrained):	$p < 0.001$		$p < 0.001$		$p < 0.001$	

Panel B. WW index

	Unconstrained_WW	Constrained_WW	Unconstrained_WW	Constrained_WW	Unconstrained_WW	Constrained_WW
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*TAXPLAN_GAAPETR*		*TAXPLAN_CashETR*		*TAXPLAN_ETR*	
Post_Pressure × Emission_Reduction	0.012	0.021**	0.011	0.016**	0.011	0.020**
	(1.61)	(2.43)	(1.03)	(2.02)	(0.91)	(2.31)
SIZE	0.013***	0.009***	0.011**	0.015***	–0.000	–0.004
	(3.352)	(2.707)	(2.267)	(3.056)	(–0.032)	(–0.861)
PPE	–0.047***	0.014	0.043**	–0.001	0.035**	0.015
	(–3.01)	(1.05)	(2.41)	(–0.07)	(2.41)	(0.98)
LEV	0.015	–0.006	–0.036**	–0.018	–0.003	0.008
	(1.06)	(–0.46)	(–2.38)	(–1.12)	(–0.22)	(0.49)
INTANG	–0.005	0.037***	0.012	–0.014	0.023	0.024
	(–0.37)	(2.94)	(0.72)	(–0.79)	(1.43)	(1.40)
ROA	0.180***	0.190***	0.453***	0.496***	0.299***	0.278***
	(9.16)	(10.14)	(16.76)	(18.88)	(13.77)	(12.11)
INV	–0.036*	–0.017	0.032	0.030	–0.032	0.009
	(–1.93)	(–0.98)	(1.32)	(1.17)	(–1.64)	(0.41)
CAPEX	0.081***	–0.015	–0.012	0.031	–0.021	0.027
	(4.35)	(–0.78)	(–0.49)	(1.26)	(–1.04)	(1.29)
DEPRECIATION	0.020	–0.324***	–0.531***	–0.362***	–0.423***	–0.406***
	(0.23)	(–3.98)	(–5.38)	(–3.32)	(–4.68)	(–4.10)
TAXRELIEF	0.017***	0.020***	–0.008**	–0.002	–0.011***	–0.013***
	(6.90)	(6.99)	(–2.00)	(–0.42)	(–3.44)	(–4.19)
MULTI	–0.008**	0.003	0.006	–0.006	–0.002	–0.006
	(–2.31)	(0.77)	(1.19)	(–1.23)	(–0.38)	(–1.55)
CarbonTax	0.008	0.001	–0.002	0.000	0.006	0.002
	(1.39)	(0.07)	(–0.32)	(0.06)	(0.79)	(0.24)
ETS	0.004	0.018***	0.035***	0.025***	0.020***	–0.001

	(0.67)	(2.71)	(3.67)	(2.95)	(3.07)	(–0.09)
Statutory Corporate Tax Rate	0.839***	0.895***	0.863***	0.883***	0.891***	0.899***
	(46.31)	(46.09)	(37.92)	(42.10)	(38.31)	(42.18)
GDPG	0.000	0.001*	0.002***	0.001	0.004***	0.002***
	(0.53)	(1.85)	(2.74)	(1.56)	(6.61)	(3.10)
Constant	–0.493***	–0.437***	–0.525***	–0.624***	–0.219**	–0.125
	(–5.74)	(–5.89)	(–4.96)	(–5.63)	(–2.47)	(–1.22)
N	20,747	20,206	19,721	20,296	19,654	20,212
Adjusted R^2	0.679	0.691	0.656	0.681	0.686	0.666
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Test for equality of coefficients (Constrained vs Unconstrained):	$p < 0.001$		$p < 0.001$		$p < 0.001$	

Note. This table reports the tax-planning responses to carbon-management pressure conditional on firms' financial flexibility, proxied by the *KZ index* (Panel A) and the *WW index* (Panel B). Firms are classified as financially constrained (unconstrained) if their pre-Agreement index value is above (below) the sample median. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-sided *t*-tests. Variable definitions appear in Appendix 3.1.

3.5.2.5. Balancing Long-term Climate Commitments Against Short-term Performance Pressures

Firms face a tension between long-term decarbonisation commitments and short-term performance pressures (e.g. Dhaliwal et al. 2011; Krüger 2015). Agency frictions can intensify this tension if managers place greater weight on near-term outcomes than on longer-horizon value creation (Jensen and Meckling 1976). External monitoring can have a similar effect when frequent earnings benchmarks and cash-flow targets increase the salience of short-term performance (e.g. Ayers et al. 2018). In this setting, tax planning offers a way to generate internal funds without cutting core operations, helping managers reconcile compliance with near-term financial targets. To examine how internal and external governance conditions shape firms' tax-planning responses to carbon-management obligations, I focus on two well-established governance mechanisms that influence short-term managerial orientation: agency costs, which reflect internal incentive conflicts that encourage myopic decision-making (Jensen 1986); and analyst coverage, which represents external monitoring that amplifies managerial attention to near-term earnings performance (Ayers et al. 2018).

I first split the sample by the agency-cost proxy (*Agency Cost*). Following Ang et al. (2000) and Singh and Davidson (2003), *Agency Cost* is measured as the ratio of selling, general and administrative expenses to sales, with higher values indicating greater agency costs. Firms with above-median pre-Agreement average *Agency Cost* are classified as high-agency-cost firms, and those below the median as low-agency-cost firms. Table 3.10, Panel A shows that the coefficient on *Post_Pressure* × *Reduced Carbon Emissions* is positive and statistically significant for high-agency-cost firms across all three measures. For low-agency-cost firms, the coefficients are insignificant. The full set of estimated coefficients differs jointly between the two groups for all specifications. Economically, high-agency-cost firms increase tax planning by approximately 2.6–3.7 percentage points after the Agreement, consistent with stronger short-term incentives to preserve cash.

I next partition firms by *Analyst Coverage*, measured as the number of analysts issuing one-year-ahead earnings forecasts, obtained from the I/B/E/S database. Firms with above-median pre-Agreement average coverage are classified as High-coverage firms, and those below the median are classified as Low-coverage firms. Table 3.10, Panel B shows that the coefficient on *Post_Pressure* × *Reduced Carbon Emissions* is positive and statistically significant for High-coverage firms, but insignificant for Low-coverage firms. The two subgroups are significantly different ($p < 0.001$). These results are consistent with the view that stronger external scrutiny increasing the focus on meeting short-term financial targets, which raises the appeal of tax-generated cash savings in the post-Agreement period.

Overall, firms subject to greater internal agency frictions or external monitoring pressure display larger post-Agreement increases in tax planning. These findings support the view that when pressures to deliver short-term performance are higher, managers rely more on tax planning to support compliance-related spending while maintaining near-term financial metrics.

Table 3.10. Balancing Long-Term Climate Commitments Against Short-Term Performance Pressures.

Panel A. Agency cost

	Low Agency Cost	High Agency Cost	Low Agency Cost	High Agency Cost	Low Agency Cost	High Agency Cost
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*TAXPLAN_GAAPETR*		*TAXPLAN_CashETR*		*TAXPLAN_ETR*	
Post_Pressure × *Emission_Reduction*	–0.001	0.028***	–0.008	0.026***	–0.013	0.037***
	(–0.15)	(3.74)	(–0.79)	(3.28)	(–1.22)	(4.01)
SIZE	0.006	0.017***	0.007	0.019***	–0.007*	0.003
	(1.60)	(4.55)	(1.61)	(3.57)	(–1.79)	(0.60)
PPE	–0.011	–0.018	0.012	0.033*	0.022	0.030*
	(–0.87)	(–1.12)	(0.77)	(1.67)	(1.64)	(1.83)
LEV	–0.009	0.020	–0.031*	–0.022	0.008	–0.002
	(–0.69)	(1.48)	(–1.90)	(–1.50)	(0.52)	(–0.17)
INTANG	0.028*	0.009	–0.022	0.01	0.019	0.024
	(1.72)	(0.74)	(–1.09)	(0.63)	(0.98)	(1.59)
ROA	0.188***	0.182***	0.503***	0.460***	0.279***	0.300***
	(9.71)	(9.60)	(19.48)	(16.71)	(12.87)	(13.25)
INV	–0.022	–0.025	0.038*	0.026	–0.002	–0.021
	(–1.41)	(–1.16)	(1.67)	(0.93)	(–0.09)	(–0.91)
CAPEX	0.033**	0.027	0.016	–0.001	0.006	–0.009
	(2.06)	(1.17)	(0.67)	(–0.02)	(0.34)	(–0.44)
DEPRECIATION	–0.122	–0.201**	–0.462***	–0.437***	–0.331***	–0.487***
	(–1.40)	(–2.47)	(–4.33)	(–4.42)	(–3.53)	(–5.45)
TAXRELIEF	0.018***	0.018***	–0.005	–0.005	–0.015***	–0.011***
	(6.10)	(7.76)	(–1.02)	(–1.45)	(–4.38)	(–3.77)
MULTI	–0.001	–0.005	–0.004	0.002	–0.008*	0.000
	(–0.31)	(–1.42)	(–0.77)	(0.54)	(–1.75)	(–0.02)
CarbonTax	–0.003	0.012**	0.002	–0.003	0.007	0.001
	(–0.49)	(2.06)	(0.34)	(–0.50)	(1.02)	(0.14)
ETS	0.008	0.011*	0.028***	0.034***	0.012	0.004
	(1.22)	(1.83)	(2.77)	(4.14)	(1.63)	(0.68)

Statutory Corporate Tax Rate	0.848***	0.891***	0.893***	0.858***	0.886***	0.909***
	(43.82)	(48.78)	(40.26)	(39.74)	(39.62)	(40.70)
GDPG	0.000	0.001*	0.001	0.002**	0.003***	0.003***
	（0.59）	（1.87）	（1.63）	（2.51）	（5.12）	（4.39）
Constant	–0.336***	–0.589***	–0.426***	–0.708***	–0.054	–0.283***
	(–4.33)	(–7.50)	(–4.36)	(–6.29)	(–0.63)	(–2.96)
N	20588	20552	20098	20090	19946	20118
Adjusted R^2	0.669	0.701	0.657	0.678	0.67	0.683
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Test for equality of coefficients (High vs. Low):	$p < 0.001$		$p < 0.001$		$p < 0.001$	

Panel B. Analyst coverage

	Low Analyst Coverage	High Analyst Coverage	Low Analyst Coverage	High Analyst Coverage	Low Analyst Coverage	High Analyst Coverage
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*TAXPLAN_GAAPETR*		*TAXPLAN_CashETR*		*TAXPLAN_ETR*	
Post_Pressure × Emission_Reduction	–0.043	0.019***	–0.017	0.011*	–0.022	0.014*
	(–1.23)	(3.29)	(–0.81)	（1.65）	(–1.03)	（1.91）
SIZE	0.011***	0.011***	0.028***	–0.009*	0.003	–0.003
	(2.91)	(2.86)	(5.18)	(–1.82)	(0.68)	(–0.70)
PPE	–0.030**	0.020	–0.000	0.063***	0.014	0.039**
	(–2.34)	(1.20)	(–0.01)	(3.39)	(1.06)	(2.35)
LEV	0.015	–0.005	–0.035**	–0.019	–0.007	0.006
	(1.12)	(–0.36)	(–2.39)	(–1.20)	(–0.49)	(0.40)
INTANG	0.009	0.012	–0.015	0.020	0.016	0.02
	(0.73)	(0.87)	(–0.81)	(1.25)	(0.94)	(1.23)
ROA	0.207***	0.148***	0.523***	0.424***	0.288***	0.278***
	(11.50)	(7.29)	(21.22)	(14.53)	–13.69	–11.507
INV	–0.037**	–0.016	0.010	0.052	–0.011	–0.014
	(–2.37)	(–0.72)	(0.49)	(1.58)	(–0.66)	(–0.55)
CAPEX	0.019	0.041	0.002	0.005	–0.025	0.061**

	(1.30)	(1.55)	(0.08)	(0.16)	(–1.49)	(2.21)
DEPRECIATION	–0.119*	–0.224**	–0.389***	–0.543***	–0.365***	–0.384***
	(–1.68)	(–2.26)	(–4.10)	(–5.02)	(–4.50)	(–3.66)
TAXRELIEF	0.013***	0.024***	–0.005	–0.007	–0.018***	–0.006*
	(6.17)	(7.29)	(–1.31)	(–1.53)	(–6.37)	(–1.73)
MULTI	–0.002	–0.004	–0.000	–0.003	–0.003	–0.003
	(–0.62)	(–0.94)	(–0.08)	(–0.53)	(–0.68)	(–0.62)
CarbonTax	–0.000	0.009*	–0.001	0.001	0.013	–0.001
	(0.00)	(1.68)	(–0.13)	(0.10)	(1.47)	(–0.17)
ETS	0.016***	–0.001	0.049***	–0.012	0.009	0.004
	(2.86)	(–0.12)	(6.08)	(–1.12)	(1.61)	(0.48)
Statutory Corporate Tax Rate	0.878***	0.860***	0.912***	0.840***	0.916***	0.877***
	(44.37)	(48.45)	(38.80)	(41.70)	(39.85)	(40.44)
GDPG	0.001	0.000	0.001*	0.001**	0.002***	0.003***
	(1.23)	(0.79)	(1.82)	(2.06)	(3.62)	(5.53)
Constant	–0.448***	–0.467***	–0.904***	–0.045	–0.266***	–0.156
	(–5.64)	(–5.54)	(–7.86)	(–0.38)	(–3.10)	(–1.47)
N	22,971	17,808	22,209	17613	22283	17446
Adjusted R^2	0.683	0.705	0.688	0.666	0.672	0.699
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Test for equality of coefficients (High vs Low):	$p < 0.001$		$p < 0.001$		$p < 0.001$	

Note. This table reports firms' tax-planning responses to carbon-management pressure conditional on agency costs and analyst coverage. In Panel A, high (low) agency cost firms are those with above- (below-) median pre-Agreement *Agency Cost*. In Panel B, high (low) coverage firms are those with above- (below-) median pre-Agreement *Analyst Coverage*. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-sided *t*-tests. Variable definitions appear in Appendix 3.1.

3.5.2.6. Institutional Variation: Civil-law versus Common-law Systems

Institutional environments shape how effectively global agreements such as the Paris Agreement are implemented. In particular, differences in legal origin influence both the stringency of policy enforcement and the predictability of compliance obligations (La Porta et al. 1997, 1998; Sarkar 2011). Common-law systems, which rely more on case-based interpretation, typically provide greater managerial discretion in responding to regulatory requirements. In contrast, civil-law systems emphasise codified rules and centralised enforcement, creating stronger and more formal compliance pressures on firms (Sarkar 2011). If civil-law countries enforce carbon policies more stringently, firms operating in these environments are likely to face higher compliance and reporting costs, thereby experiencing greater incentives to engage in tax planning to offset these expenditures. At the same time, stronger institutional oversight in civil-law systems may increase the visibility of tax planning, leading to higher reported activity even without a proportional change in underlying behaviour.

To test this conjecture, I classify countries according to the legal origin of their system (i.e. civil law or common law), following La Porta et al. (1997, 1998). Table 3.11 shows that the coefficients on *Post_Pressure* × *Reduced Carbon Emissions* are positive and statistically significant for the civil-law subsample (0.014–0.025 across specifications) but insignificant for the common-law subsample. The two subsamples are significantly different ($p < 0.001$). These results suggest that the Paris Agreement induces a stronger tax-planning response among firms in civil-law jurisdictions.[27]

[27] An alternative interpretation is that common-law countries have more developed capital markets and stronger shareholder litigation mechanisms (La Porta et al. 1997, 1998), which may independently constrain aggressive tax planning even under climate pressure. Under this view, the weaker effect in common-law jurisdictions reflects investor monitoring rather than differences in regulatory enforcement stringency.

Table 3.11. Institutional Variation: Civil-Law versus Common-Law Systems.

	Civil	Common	Civil	Common	Civil	Common
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*TAXPLAN_GAAPETR*		*TAXPLAN_CashETR*		*TAXPLAN_ETR*	
Post_Pressure × *Emission_Reduction*	0.014*	0.012	0.015*	0.005	0.025**	–0.003
	(1.79)	(1.17)	(1.65)	(0.55)	(2.52)	(–0.35)
SIZE	0.009***	0.016***	0.017***	0.002	–0.005	–0.005
	(2.73)	(2.78)	(3.32)	(0.25)	(–1.30)	(–0.72)
PPE	–0.034*	–0.005	0.020	0.025	0.003	0.027
	(–1.93)	(–0.25)	(0.94)	(0.88)	(0.20)	(1.19)
LEV	0.000	0.002	–0.049***	–0.009	–0.009	–0.016
	(–0.01)	(0.11)	(–2.69)	(–0.45)	(–0.54)	(–0.92)
INTANG	0.021	0.005	–0.016	0.025	0.019	0.008
	(1.61)	(0.24)	(–0.87)	(1.07)	(1.20)	(0.29)
ROA	0.182***	0.213***	0.490***	0.505***	0.306***	0.340***
	(9.58)	(7.15)	(17.41)	(12.21)	(13.60)	(9.81)
INV	–0.037**	–0.011	0.048	0.009	0.002	–0.004
	(–2.25)	(–0.34)	(1.48)	(0.24)	(0.08)	(–0.13)
CAPEX	0.058***	0.016	0.033	–0.021	0.033	0.018
	(2.72)	(0.48)	(1.07)	(–0.51)	(1.55)	(0.44)
DEPRECIATION	–0.012	–0.295***	–0.489***	–0.483***	–0.299***	–0.556***
	(–0.14)	(–2.59)	(–4.39)	(–3.41)	(–3.27)	(–4.24)
TAXRELIEF	0.014***	0.026***	–0.003	–0.014***	–0.014***	–0.012**
	(7.04)	(5.81)	(–0.97)	(–2.68)	(–5.41)	(–2.35)
MULTI	–0.003	–0.006	0.005	–0.007	–0.008*	–0.011*
	(–0.91)	(–1.23)	(0.78)	(–1.11)	(–1.69)	(–1.78)
CarbonTax	0.007	–0.009	0.003	–0.008	–0.006	0.005
	(1.10)	(–1.04)	(0.33)	(–0.88)	(–0.87)	(0.58)
ETS	0.020***	–0.010	0.049***	–0.020	0.005	–0.001
	(3.57)	(–0.91)	(6.36)	(–1.51)	(0.85)	(–0.09)
Statutory Corporate Tax Rate	0.948***	0.193	0.914***	0.647***	0.891***	0.262

	(33.66)	(1.09)	(27.66)	(3.65)	(27.35)	(1.42)
GDPG	0.002**	–0.002**	0.003***	–0.002*	0.003***	0.001
	(2.42)	(–2.32)	(3.70)	(–1.79)	(3.98)	(1.05)
Constant	–0.444***	–0.459***	–0.711***	–0.223	–0.090	0.013
	(–5.94)	(–3.56)	(–6.57)	(–1.49)	(–1.08)	(0.08)
N	18,532	9,321	17,707	9,403	18,308	8,991
Adjusted R^2	0.589	0.674	0.638	0.641	0.597	0.644
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Test for equality of coefficients (Civil vs Common):	$p < 0.001$		$p < 0.001$		$p < 0.001$	

Note. This table reports firms' tax-planning responses to carbon-management pressure arising from the Paris Agreement by legal origin. Countries are classified as civil-law or common-law following La Porta et al. (1997, 1998). Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-sided *t*-tests. Variable definitions appear in Appendix 3.1.

3.6. Other Robustness Checks

In this section, I run a set of robustness checks, beyond the parallel-trends analyses in Section 3.5.1, and the inferences remain unchanged. First, I verify that my results are not sensitive to alternative tax-planning measures. I re-estimate the baseline model using a cash-flow-scaled measure of *TAXPLAN* and book-tax conformity (*BTC*). As presented in Table 3.12 columns (1)–(2), the coefficients on *Post_Pressure* × *Reduced Carbon Emissions* are positive and statistically significant for both outcomes. I then construct three five-year versions of *TAXPLAN* by summing each element in the *TAXPLAN* computation over the previous four years and the current year, based on *GAAP ETR*, *Cash ETR* and *ETR*. Columns (3)–(5) of Table 3.12 present positive and statistically significant estimates across all three long-term measures. The magnitudes are similar to the baseline and consistent with an increase in tax planning after the Agreement among firms that reduce emissions.

Table 3.12. Alternative Dependent Variables.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	*Cash–flow–scaled TAXPLAN*	*BTC*	*Long–term TAXPLAN_ GAAP ETR*	*Long–term TAXPLAN _Cash ETR*	*Long–term TAXPLAN_ETR*
Post_Pressure × *Emission_Reduction*	0.014**	0.023**	0.039***	0.039***	0.043***
	(2.23)	(2.23)	(5.81)	(5.72)	(5.57)
SIZE	–0.012***	0.027***	0.010***	0.014***	0.008**
	(–3.92)	(3.91)	(2.94)	(3.52)	(2.28)
PPE	0.053***	0.020	–0.025**	0.029**	0.028**
	(4.30)	(0.77)	(–2.04)	(2.09)	(2.18)
LEV	0.009	–0.056***	–0.001	–0.041***	–0.015
	(0.83)	(–2.96)	(–0.12)	(–3.59)	(–1.34)
INTANG	0.039***	0.011	0.010	0.009	0.009
	(3.56)	(0.34)	(1.05)	(0.73)	(0.80)
ROA	–0.141***	0.710***	0.152***	0.378***	0.214***
	(–8.52)	(13.71)	(10.71)	(21.43)	(14.01)
INV	–0.311***	0.003	–0.035***	0.014	–0.047***
	(–13.71)	(0.06)	(–2.70)	(0.77)	(–3.14)
CAPEX	–0.117***	0.019	0.042***	0.013	0.023
	(–6.69)	(0.41)	(2.99)	(0.70)	(1.45)
DEPRECIATION	0.859***	–0.578***	–0.039	–0.267***	–0.267***
	(12.79)	(–4.01)	(–0.65)	(–3.59)	(–3.87)
TAXRELIEF	0.002	–0.022*	0.010***	–0.003	–0.006***
	(0.84)	(–1.80)	(5.10)	(–0.93)	(–2.66)

MULTI	–0.004	0.003	0.000	–0.002	0.000
	(–1.11)	(0.37)	(–0.02)	(–0.53)	(0.00)
CarbonTax	0.007	0.079	–0.004	–0.009*	0.001
	(1.60)	(1.17)	(–0.78)	(–1.76)	(0.20)
ETS	0.000	0.042**	0.009**	0.017***	–0.007
	(0.03)	(2.44)	(2.22)	(2.79)	(–1.42)
Statutory Corporate Tax Rate	0.944***	0.872***	0.902***	0.903***	0.938***
	(54.73)	(30.77)	(65.42)	(60.03)	(61.51)
GDPG	0.000	0.002*	0.001**	0.001***	0.002***
	(0.45)	(1.73)	(2.30)	(3.39)	(5.98)
Constant	0.045	–0.948***	–0.472***	–0.618***	–0.421***
	(0.67)	(–5.91)	(–6.21)	(–7.05)	(–5.30)
N	38,855	40,254	36,760	34,923	35,426
Adjusted R^2	0.623	0.280	0.738	0.745	0.731
Year FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes

Note. This table reports robustness tests using alternative tax-planning measures. Columns (1)-(2) use a cash-flow-scaled measure of *TAXPLAN* and book-tax conformity (*BTC*) as dependent variables. Columns (3)-(5) use five-year cumulative versions of *TAXPLAN_GAAPETR*, *TAXPLAN_CashETR*, and *TAXPLAN_ETR*, constructed by summing the underlying elements over the current and previous four years. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-sided *t*-tests. Variable definitions appear in Appendix 3.1.

Second, I control for the non-random assignment of emissions-reduction status using entropy balancing. This preprocessing approach retains the full sample while achieving covariate balance between treated and control observations. The treated firms are those subject to reductions in carbon emissions (*Emission_Reduction* = 1), and the control sample consists of firm-year observations without reductions in carbon emissions (*Emission_Reduction* = 0). By adjusting unit weights through the entropy balancing method, I can effectively adjust for 'systematic and random inequalities in representation' without sacrificing observations (Hainmueller 2012: 26). I implement the entropy balancing method by reweighting the control observations to match the treated group's covariate distributions with respect to the first moment (mean) of the firm-level characteristics included in Equation (1). Table 3.13 presents the regression results based on the sample that is entropy balanced, showing that my main inferences remain qualitatively unchanged, suggesting that differences in covariate distributions between the treatment and control groups do not drive my results.

Table 3.13. Entropy-Balanced Regressions.

VARIABLES	(1) *TAXPLAN_GAAPETR*	(2) *TAXPLAN_CashETR*	(3) *TAXPLAN_ETR*
Post_Pressure × Emission_Reduction	0.018***	0.011*	0.017**
	(3.23)	(1.76)	(2.33)
SIZE	0.021***	0.012*	0.001
	(4.09)	(1.68)	(0.16)
PPE	–0.039	0.042*	0.029
	(–0.88)	(1.71)	(1.33)
LEV	0.012	–0.056***	–0.033*
	(0.62)	(–2.94)	(–1.66)
INTANG	0.035**	0.041**	0.058***
	(2.14)	(2.33)	(3.19)
ROA	0.143***	0.475***	0.369***
	(4.68)	(11.28)	(10.22)
INV	–0.040	0.053	–0.039
	(–1.30)	(1.11)	(–0.99)
CAPEX	0.116**	0.062	0.144***
	(2.09)	(1.20)	(2.98)
DEPRECIATION	0.017	–0.287**	–0.292**
	(0.10)	(–2.00)	(–2.26)
TAXRELIEF	0.022***	–0.005	–0.009*
	(4.50)	(–1.13)	(–1.82)
MULTI	–0.009	–0.011*	–0.007
	(–1.35)	(–1.68)	(–0.95)
CarbonTax	0.014	–0.001	–0.001
	(1.61)	(–0.12)	(–0.10)
ETS	–0.002	–0.004	0.006
	(–0.23)	(–0.38)	(0.80)
Statutory Corporate Tax Rate	0.850***	0.799***	0.841***
	(32.44)	(28.13)	(28.32)
GDPG	0.000	0.002**	0.004***
	(0.40)	(2.20)	(4.26)
Constant	–0.717***	–0.522***	–0.257
	(−4.45)	(–3.23)	(–1.61)
N	41,199	40,248	40,117
Adjusted R^2	0.661	0.645	0.653
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Note. This table reports regression results after reweighting control observations using the entropy balancing method. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-sided *t*-tests. Variable definitions appear in Appendix 3.1.

Third, to address the concern that 2016 may represent a transitional year because the Paris Agreement became effective in November of that year, I exclude all 2016 observations. Panel A of Table 3.14 shows that excluding the transitional year does not alter the results.

Fourth, I implement an alternative DID design that uses countries that had not entered into the Paris Agreement before 2019 as the control group. Specifically, Bermuda, the Cayman Islands, and the Isle of Man did not sign, and Colombia, Kenya and Trinidad and Tobago ratified in 2019. Panel B of Table 3.14 shows consistent evidence under an alternative design, and the main inferences hold.

Taken together, the findings are robust to alternative outcome definitions, covariate reweighting, an alternative DID design based on non-signers and late ratifiers, and the exclusion of 2016.

Table 3.14. Robustness to Alternative Sample and Identification Settings.

Panel A. Excluding transitional year (2016)

VARIABLES	(1) *TAXPLAN_GAAPETR*	(2) *TAXPLAN_CashETR*	(3) *TAXPLAN_ETR*
Post_Pressure × Emission_Reduction	0.017***	0.015**	0.018**
	(2.65)	(2.24)	(2.29)
SIZE	0.011***	0.012***	–0.002
	(4.16)	(3.52)	(–0.65)
PPE	–0.015	0.022*	0.027**
	(–1.36)	(1.68)	(2.35)
LEV	0.005	–0.021*	0.002
	(0.48)	(–1.80)	(0.19)
INTANG	0.019*	–0.005	0.025**
	(1.95)	(–0.43)	(2.01)
ROA	0.192***	0.484***	0.297***
	(13.44)	(24.70)	(17.92)
INV	–0.031**	0.025	–0.015
	(–2.28)	(1.32)	(–0.98)
CAPEX	0.028*	–0.002	–0.004
	(1.87)	(–0.12)	(–0.24)
DEPRECIATION	–0.139**	–0.416***	–0.401***
	(–2.26)	(–5.63)	(–5.92)
TAXRELIEF	0.019***	–0.004	–0.013***
	(10.05)	(–1.32)	(–5.36)
MULTI	–0.003	0.000	–0.004
	(–1.15)	(0.03)	(–1.12)

CarbonTax	0.005	0.000	0.004
	(1.08)	(0.08)	(0.85)
ETS	0.010**	0.029***	0.008*
	(2.45)	(4.65)	(1.93)
Statutory Corporate Tax Rate	0.869***	0.874***	0.895***
	(65.37)	(56.98)	(57.32)
GDPG	0.001*	0.001***	0.003***
	(1.75)	(2.96)	(6.26)
Constant	–0.463***	–0.561***	–0.174**
	(–8.00)	(–7.19)	(–2.58)
N	36,868	35,969	35,750
Adjusted R^2	0.677	0.658	0.668
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Panel B. Alternative identification design: Non–signatory and late–ratifying countries

	(1)	(2)	(3)
VARIABLES	*TAXPLAN_GAAPETR*	*TAXPLAN_CashETR*	*TAXPLAN_ETR*
Post_Pressure × Treat	0.030***	0.029***	0.035***
	(4.97)	(4.67)	(5.04)
SIZE	0.010***	0.012***	–0.002
	(4.14)	(3.65)	(–0.80)
PPE	–0.016	0.021*	0.026**
	(–1.51)	(1.70)	(2.48)
LEV	0.006	–0.026**	0.003
	(0.61)	(–2.37)	(0.28)
INTANG	0.018*	0.000	0.022*
	(1.93)	(0.02)	(1.92)
ROA	0.182***	0.474***	0.286***
	(13.56)	(25.12)	(18.25)
INV	–0.025**	0.031*	–0.010
	(–1.97)	(1.77)	(–0.70)
CAPEX	0.028**	0.004	–0.002
	(2.03)	(0.25)	(–0.16)
DEPRECIATION	–0.154***	–0.431***	–0.405***
	(–2.62)	(–5.97)	(–6.29)
TAXRELIEF	0.018***	–0.005*	–0.013***
	(9.83)	(–1.76)	(–5.92)
MULTI	–0.003	–0.000	–0.004
	(–1.27)	(–0.14)	(–1.34)
CarbonTax	0.004	–0.002	0.003
	(0.82)	(–0.41)	(0.56)
ETS	0.010**	0.031***	0.008*
	(2.36)	(4.95)	(1.69)
Statutory Corporate Tax Rate	0.870***	0.877***	0.899***
	(65.35)	(56.79)	(56.92)
GDPG	0.001***	0.002***	0.003***
	(2.86)	(3.84)	(7.74)
Constant	–0.466***	–0.578***	–0.185***
	(–8.40)	(–7.66)	(–2.83)

N	41,199	40,248	40,117
Adjusted R^2	0.686	0.670	0.677
Year FE	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes

Note. This table reports robustness tests under alternative sample and identification settings. Panel A excludes all 2016 observations to account for potential transition effects when the Paris Agreement became effective in November 2016. Panel B implements an alternative DID design using countries that had not signed or ratified the Paris Agreement before 2019 as the control group. Standard errors are clustered at the firm level and reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively, based on two-sided *t*-tests. Variable definitions appear in Appendix 3.1.

3.7. Conclusion

I find that firms reducing emissions after the Paris Agreement engage in greater tax planning than firms that are not reducing emissions. This evidence identifies tax planning as a previously overlooked adjustment channel through which climate policy, while environmental in nature, influences firms' financial behaviour. Drawing on the NRBV and cost pass-through economics, I show that the effect is stronger where firms have lower capacity to transfer costs externally and face tighter financing conditions. Specifically, the increase in tax planning is more pronounced for firms operating in competitive markets, where they have weaker pricing power or lower financial flexibility. It is also greater among firms with aggressive tax histories, higher agency costs, greater analyst coverage and in civil-law countries.

These results have implications for policy and practice. Climate measures such as carbon pricing can unintentionally encourage firms with limited cost pass-through capacity or financial flexibility to rely more on tax planning, which may undermine the stability of the corporate tax base. This evidence indicates that climate policy can influence government fiscal outcomes through firms' behavioural adjustments. Understanding these interdependencies is important for assessing the broader economic consequences of global climate initiatives. Overall, the results suggest that closer coordination between climate and tax systems could help reduce unintended financial responses and support more balanced policy outcomes.

While this research contributes important knowledge to the literature, this study is not without limitations. As with all research on large-scale regulatory reforms, particularly those conducted in cross-country settings, a key concern is the potential influence of concurrent macroeconomic or institutional changes. To mitigate this concern, I control for the presence of emissions trading schemes and carbon tax policies, and I conduct a range of robustness tests, including alternative samples, trend analyses and placebo tests. While these approaches reduce the likelihood of confounding effects, they may not completely eliminate them. I acknowledge this as a potential limitation and leave it open for future research to further isolate the effects of the Paris Agreement from other contemporaneous policy or economic developments. In addition, although this study provides international evidence, future research could extend the analysis to different institutional or policy environments to enhance understanding of the Paris Agreement's firm-level financial consequences.

Appendix 3.1. Variable Definitions and Data Sources.

Variable	Definition	Data Source
Dependent Variables		
TAXPLAN	Tax planning measure, computed as the country's statutory corporate tax rate (*Statutory Corporate Tax Rate*) less *GAAP ETR*, *Cash ETR*, and *ETR*, respectively. Each element in the computation is summed over the previous two years and the current year. A higher value indicates a greater degree of tax planning.	Compustat
Long-term TAXPLAN	Long-run tax planning measure. Each element in the *TAXPLAN* computation is summed over the previous four years and the current year. A higher value indicates a greater degree of tax planning.	Compustat
Cash-flow-scaled TAXPLAN	Cash-flow-scaled tax planning measure, computed as the country's statutory corporate tax rate (*Statutory Corporate Tax Rate*) less total income tax expense divided by net cash flows from operations. Each element in the computation is summed over the previous two years and the current year. A higher value indicates a greater degree of tax planning.	Compustat
BTC	Book-tax conformity (*BTC*) is the flexibility that a firm has to report taxable income that is different from pre-tax-book income in a given country year.	Compustat
Variables of Interest		
Post_Pressure	An indicator variable equal to one beginning in the year (i.e., year 2016) in which the Paris Agreement becomes effective, and zero otherwise.	Own construction
Emission_Reduction	An indicator variable equal to one if a firm's average level of *Carbon Emissions* over the five years after agreement is less than the average level of *Carbon Emissions* over the five years before the agreement, and zero otherwise.	Own construction
Treat_Alternative	An indicator variable equal to one if a firm is in a country that accepted and ratified the agreement before 2019, and zero otherwise.	Own construction
Year -4plus *(Year –3)* *(Year –2)* (*Year -1*)	An indicator variable equal to one a given year is 4 more years (*Year -4plus*), 3 years (*Year -3*), 2 years (*Year -2*), or 1 year (*Year -1*) before implementation of the Paris Agreement, and zero otherwise.	Own construction
Year 0	An indicator variable equal to one for the year of implementation (*Year 0*) of the Paris Agreement, and zero otherwise.	Own construction
Year 1 *(Year 2)* *(Year 3)* *(Year 4plus)*	An indicator variable equal to one for the first year (*Year 1*), second year (*Year 2*), third year (*Year 3*), or fourth year and subsequent years (*Year 4plus*) after the implementation of the Paris Agreement, and zero otherwise.	Own construction
After agreement_Pseudo1 (*After agreement_Pseudo2*)	An indicator variable equal to one if a given year is the year following the pseudo-agreement year, and zero otherwise.	Own construction
Control Variables		
SIZE	Natural logarithm of prior year total assets.	Compustat
PPE	Property, plant, and equipment divided by prior year total assets.	Compustat

LEV	The ratio of total debt to prior year total assets.	Compustat
INTANG	Intangible assets scaled by prior year total assets.	Compustat
ROA	Pre-tax income divided by prior year total assets.	Compustat
INVENTORY	Inventory scaled by prior year total assets.	Compustat
CAPEX	Capital expenditures scaled by prior year total assets.	Compustat
DEPRECIATION	Depreciation expense divided by prior year total assets.	Compustat
TAXRELIEF	An indicator variable equal to one if the firm utilizes deferred tax assets to reduce current tax expense, zero otherwise.	Compustat
MULT	An indicator variable for non-zero international operating income, to capture multinational operations.	Compustat
CarbonTax	An indicator variable equal to one if a carbon tax is in effect in a given country-year, zero otherwise.	World Bank (Carbon Pricing Dashboard)
ETS	An indicator variable equal to one if an emissions trading scheme is implemented in a given country-year, zero otherwise.	World Bank (Carbon Pricing Dashboard)
Statutory Corporate Tax Rate	Country-level corporate tax rate.	OECD tax database
GDPG	GDP growth.	World Bank
<u>Other Variables</u>		
HHI	Herfindahl-Hirschman Index (*HHI*) measuring industry concentration. It is calculated as the sum of squared market shares of all firms operating in the same four-digit industry and year, where market share is defined as a firm's sales divided by the total sales of its industry-year. A higher *HHI* indicates a more concentrated industry (lower competition), while a lower *HHI* reflects a more competitive market environment.	Compustat
Profit Margin	Net income scaled by the total revenue.	Compustat
B2C	An indicator variable equal to one if the firm is in the in business-to-consumer (*B2C*) industries, and zero otherwise.	Compustat
KZ index	Financial constraints index constructed following Lamont et al. [2001]. It is calculated as {−1.001909 × [((Income before extraordinary items + Depreciation) ÷ Lag property, plant, and equipment)]} + {0.2826389 × [(Total assets + December market capitalization in prior year − Common equity − Deferred taxes) ÷ Total assets]} + {3.139193 × [(Long-term debt + Short-term debt) ÷ (Long-term debt + Short-term debt + Shareholders' equity)]} − {39.3678 × [(Common dividends DVC + Preferred dividends) ÷ Lag property, plant, and equipment]} − {1.314759 × [(Cash ÷ Lag property, plant, and equipment)]}. All of the individual components of the KZ Index are winsorized at the 5% level.	Compustat
WW index	Financial constraints index proposed by Whited and Wu [2006]. It is calculated as {−0.091 × [(Income before	Compustat

	extraordinary items + Depreciation) ÷ Total assets]} − {0.062 × Dividend paying indicator} + {0.021 × (Long-term debt ÷ Total assets)} − {0.044 × Ln (Total assets)} + {0.102 × Average yearly sales growth at three-digit SIC level} −{0.035 × [(Sales − Lag Sales) ÷ Lag Sales]}. All of the individual components of the WW Index are winsorized at the 5% level.	
Agency Cost	Measured as the ratio of selling, general, and administrative expenses to sales.	Compustat
Analyst Coverage	Measured as the number of financial analysts providing one-year-ahead earnings forecasts for the firm in a given year.	I/B/E/S
Civil Law	An indicator variable equal to one if the 'origin' of a country's legal system falls into the 'civil law' systems, and zero otherwise.	La Porta et al. (1997, 1998)
GAAP_ETR	Total tax expense divided by net income before tax.	Compustat
Cash_ETR	Cash paid for taxes divided by net income before tax.	Compustat
ETR	Current tax expense divided by net income before tax.	Compustat

Appendix 3.2. Title Page of the Original Journal Article.

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RESEARCH ARTICLE OPEN ACCESS

Tax Planning Under Pressure: The Impact of Carbon Emissions Management Post-Paris Agreement

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Received: 6 February 2025 | **Revised:** 16 November 2025 | **Accepted:** 11 January 2026

Keywords: climate policy | corporate tax planning | cost pass-through | institutional heterogeneity | Paris agreement

ABSTRACT

We examine how the Paris Agreement affects corporate tax planning across a global data set. We find that emissions-reducing firms are associated with higher levels of tax planning than nonemissions-reducing firms. The effect is stronger for firms facing tighter cost pass-through constraints, such as operating in more competitive markets, with weaker pricing power or lower financial flexibility. This effect is also stronger for firms with aggressive tax histories, higher agency costs, greater analyst coverage and in civil-law countries. The evidence suggests that climate-related cost pressures influence firms' tax planning, indicating the need to consider tax implications when evaluating climate policy outcomes.

1 | Introduction

The Paris Agreement has triggered a wave of climate policy expansion, intensifying the regulatory and cost pressures on firms (Degryse et al. 2023). The Agreement articulates a legally binding global mechanism to accelerate action to mitigate climate change over time and establishes a long-term goal of limiting the global average temperature increase to well below 2°C and pursuing efforts to cap it at 1.5°C above preindustrial levels (Wu et al. 2022). This climate objective is accompanied by a legally binding review mechanism under which countries submit nationally determined contributions (NDCs), outlining mitigation and adaptation goals and identifying implementation challenges (including the means of implementation, such as technology transfer, capacity building and financing through the Green Climate Fund) as well as issues of comparability and equity (Salman et al. 2022; Stua et al. 2022).[1] The signatories to the Paris Agreement periodically assess progress through global stocktaking exercises that evaluate collective advancement towards the Agreement's objectives using the best available science (Bajaj and Thakur 2022). To achieve the goals from the NDCs, many jurisdictions have employed national carbon-pricing initiatives that detail the optimum pathways for achieving the objectives of the Paris Agreement. By 2021, 67 carbon-pricing initiatives, including carbon taxes and emissions trading schemes, had been implemented or scheduled at national and subnational levels (World Bank 2021).[2] This expansion of climate policy reflects the Agreement's influence in raising awareness of climate risks and encouraging policymakers to strengthen enforcement through the polluter pays principle (Organisation for Economic Co-operation and Development 1992), which aims to internalise greenhouse gas (GHG) emissions and incentivise low-carbon transition by imposing a financial cost on polluting behaviour (World Bank 2021; Errendal et al. 2023).[3]

Although the Paris Agreement has significantly influenced both policy development and global environmental efficiency (Salman et al. 2022; Stua et al. 2022), its firm-level financial implications remain insufficiently understood.[4] Climate-related cost shocks, including rising carbon prices, emissions taxes and abatement and compliance costs, create a valuable setting to examine how firms adjust their financial strategies in response to climate-related cost pressures under the Paris Agreement. One important financial response of firms that

Chapter 4. Essay 3: When R&D Is Rare, the Market Prices It: Evidence from Australian Junior Mining Firms

4.1. Introduction

Prior research has examined the relationship between Research & Development (R&D) investment and firm performance across a wide range of industries, yielding mixed results. Studies using broad cross-sectional samples document a positive association between R&D and firm value (Lev and Sougiannis 1996; Aboody and Lev 2000; Ehie and Olibe 2010), sales growth (Filatotchev and Piesse 2009), and investment opportunities (Borisova and Brown 2013), while others report contrary or insignificant effects (e.g., Majocchi and Zucchella 2003). These mixed findings suggest that the valuation effect of R&D is conditional on measurement choices, firm characteristics, and industry context. In particular, using broad cross-industry samples may mask heterogeneity in the R&D–value relationship, and an estimated average across industries may be the net result of widely differing relationships that counteract each other (Cui and Mak 2002). This limitation is especially relevant in the mining industry, which is characterised by unique fundamentals, severe geological uncertainty, and distinct firm economics. Despite the important role that junior mining firms (JMFs) play in resource discovery, accounting for approximately 60 percent of major discoveries in Australia since the 1960s (Hogan et al. 2002), no prior study has examined whether and how R&D investment affects the market valuation of JMFs. Therefore, this study examines the association between R&D intensity and firm value for Australian JMFs listed on the ASX from 2000 to 2019, and explores the conditions under which the valuation effect is stronger.

The mining industry faces technical constraints such as declining ore grades and deeper deposits, as well as stronger environmental and social expectations (Adler et al. 2017; Deloitte 2019). These pressures have increased attention on new exploration and processing methods.

For Australian JMFs, which are small, listed firms that often have limited operating cash flows, valuation is especially sensitive to information about project quality, technical progress, and future financing prospects. In this setting, even modest R&D spending can be salient if it produces technical information that helps de-risk projects,[28] or if it signals managerial capability and project credibility to outside investors. Consistent with this setting, a survey by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2021) reports that many Small and Medium-Sized Enterprises, including JMFs, face barriers to conducting R&D because of financial and operational constraints.

Because of these constraints, JMFs are generally not expected to invest heavily in R&D (Audretsch et al. 2014). This is also reflected in the data, where R&D investment is infrequent and the median R&D intensity is zero. This creates an open and testable question that prior research has not addressed in the mining context: when a JMF invests in R&D, does the market price this investment, and under what conditions is the valuation effect stronger or weaker? Drawing on the Australian Securities and Investments Commission's (ASIC) market capitalization threshold (ASIC 2006), I define JMFs as small- and mid-cap firms with a market capitalization of AUD 500 million or less.

There are several reasons why R&D investment may affect firm valuation in the JMF setting. First, R&D can generate technical knowledge that reduces geological and processing uncertainty (McManus et al. 2021; Freire da Silva et al. 2025), which can affect investors' expectations about future project cash flows (Lindi et al. 2024). Second, because JMFs frequently rely on external capital (Kreuzer et al. 2007; Iddon et al. 2015), R&D can affect financing conditions by supporting due diligence (Anderson 2000), partnerships (Martínez-

[28] This study explicitly excludes drilling programs solely aimed at expansion and identification of new areas from its definition of R&D projects. Instead, I define R&D investment as initiatives that surpass mere mineral discovery, highlighting efforts that contribute to technological advancement and sustainable development.

Noya and Narula 2018), and access to policy support (such as tax incentives) (Hall and Van Reenen 2000; Bloom et al. 2002). Meanwhile, R&D outcomes are uncertain, and benefits may be delayed (Eberhart et al. 2004; Curtis et al. 2020; Leung and Sharma 2021), so market recognition may not be immediate. Drawing on the resource-based view (RBV), technical knowledge created through R&D can be a firm-specific asset that is hard to copy (Barney 1991). In a setting with limited revenue information, the decision to invest in R&D can also function as a quality signal that investors may incorporate into valuation.

To summarize these arguments in the JMF setting, I first conduct semi-structured interviews with senior management from several JMFs. The interviews suggest that JMFs use R&D selectively to solve project-specific geological or processing problems, improve resource definition, and strengthen the credibility of project plans when seeking funding. Meanwhile, interviewees emphasise that budget constraints and limited internal capability restrict the scale of R&D activities and that R&D rarely leads to immediate share price responses. These insights motivate my focus on a longer horizon and on channels related to information and financing.

I then perform empirical analyses to examine the association between R&D intensity and firm valuation among Australian JMFs from 2000 to 2019, and whether this association varies systematically with firm characteristics. Because a firm's involvement in R&D investment is not random (Cho and Lee 2021), I employ the entropy balancing method to balance on the first three moments, addressing covariate imbalance (Hainmueller 2012; McMullin and Schonberger 2018; Kuang et al. 2021). I find that higher R&D intensity is positively associated with firm valuation measured by the marketable proxy (i.e., Tobin's Q), with the strongest effects reflecting a two-to-four-year horizon. The estimates indicate economically meaningful magnitudes. In the entropy-balanced sample, a one-standard-deviation increase in R&D intensity is associated with about a 0.38 increase in Tobin's Q three years later; using the sample mean total assets (AUD 8.82 million), this corresponds to roughly AUD 3.35 million higher market value of equity, holding book values constant. I conduct a series of robustness tests, including a falsification test, a difference-in-differences (DID) approach based on the 2012 Australian R&D Tax Incentive, propensity score matching (PSM), alternative valuation measures, and sample exclusions.

Motivated by the interview insights, I also examine cross-sectional variation in the valuation association. I find stronger valuation effects for JMFs with multinational operations and for firms with lower agency costs and lower financial distress, consistent with the idea that financing capacity and governance affect the extent to which R&D is translated into value. I also find that the valuation association is concentrated in the precious metals sector.

This study contributes to the literature on R&D and firm valuation in three ways. First, I provide evidence from a setting in which R&D spending is uncommon and firms often have limited operating cash flows (Kreuzer et al. 2007; Iddon et al. 2015). In such settings, information asymmetry is likely to be high, and even relatively small R&D outlays can carry valuation-relevant information about project quality and future prospects (Lev and Sougiannis, 1996; Aboody and Lev, 2000; Curtis et al., 2020). This study contributes by showing that, in Australian junior mining firms, R&D intensity is positively associated with firm value and that the association is most pronounced over a medium horizon (between the two- and four-year lags), consistent with delayed market recognition of R&D benefits in a resource-constrained setting.

Second, I show that the R&D–valuation association varies systematically with firm characteristics linked to financing capacity and governance. Consistent with the view that financing frictions and monitoring shape the returns to intangible investment (Le et al. 2006; Borisova and Brown 2013; Chan et al. 2015), the association is stronger for JMFs with multinational operations and lower agency costs, and weaker for firms facing greater financial distress. I also document heterogeneity across mining sub-sectors: the positive association is concentrated in precious and high-value metals, while it is not present for industrial metals and broad mining operations. This sub-sector evidence helps clarify when R&D is more likely to be priced by the market and addresses the concern that pooled estimates can mask industry-specific valuation structures (Cui and Mak 2002; Filippou and King 2011; Balci and Kumral 2022).

The remainder of this paper proceeds as follows. Section 4.2 discusses the institutional background of JMFs' R&D investment, including my interview findings. I then develop the hypothesis in section 4.3, while section 4.4 describes my empirical methodology. Section 4.5 presents the results, and then section 4.6 discusses robustness analyses and additional tests. Finally, section 4.7 concludes the paper.

4.2. Institutional Background, R&D Literature, and Anecdotes from Interviews

4.2.1. Institutional Background – The Unique Challenges of JMFs

Data from Geoscience Australia shows that JMFs have accounted for around 60 percent of total discoveries, rediscoveries, and renewals for gold, base metals, and nickel since the 1960s (Hogan et al. 2002). While these firms play an important role in generating new resource opportunities, they typically operate with limited internal resources and face substantial uncertainty about project outcomes.

Resource constraints are especially salient for JMFs because many operate with limited revenue while incurring sizeable exploration, evaluation, and development expenditures (Kreuzer et al. 2007; Iddon et al. 2015). As a result, they often need to raise external capital repeatedly to advance projects and sustain operations (Kreuzer et al. 2007; Iddon et al. 2015). This financing dependence matters for how investors value these firms: market prices reflect expectations about future project outcomes and the firm's ability to fund progress, rather than current operating cash flows. It also implies that discretionary investments such as R&D may be assessed not only as inputs into technical improvement, but also as information that can shape investor beliefs about project credibility and future financing prospects.

Meanwhile, JMFs face constraints that limit the scale and continuity of formal R&D activity. Compared with larger mining firms, junior firms often lack access to advanced infrastructure and specialist systems that support sustained innovation activities (Bygstad and Aanby 2010). They may also have limited in-house technical teams dedicated to R&D, which increases reliance on external partners and consultants. Although university–industry collaborations can support the development and transfer of scientific knowledge (Furman et al. 2002; Chai and Shih 2016), such collaborations are often less accessible to small firms with limited organizational capacity. Prior research also suggests that absorptive capacity helps firms translate knowledge inputs into outcomes (Cainelli et al. 2015), which is a further challenge for many JMFs.

External conditions further shape the incentives and constraints around R&D. Commodity price fluctuations, regulatory requirements,[29] and operational complexity add uncertainty and can shift attention toward short-term project advancement and compliance needs (Rudenno 2004; Dey and Reepmeyer 2015). Mining-specific technical pressures, including declining ore grades and the need to reduce energy use and emissions, may increase the demand for technical solutions, but they also compete for limited budgets in small firms (Filippou et al. 2011; Balci and Kumral 2022). These features help explain why R&D spending is uncommon in the junior segment and why the valuation implications of R&D may depend on firm circumstances. In particular, differences in access to resources and networks (for example through international

[29] JMFs face other legislative requirements, such as *The Native Title Act* of 1993 and amended 1998. While most tenements are issued without comment/opposition from traditional landowners, the situation can change once a discovery is made.

activity), governance frictions, and financial constraints can affect whether R&D is sustained and whether its benefits are recognized by the market, motivating my later cross-sectional and mediation analyses.

4.2.2. Prior Research on R&D investment

This study's theoretical framework integrates R&D investment and the financial performance of JMFs, drawing primarily on the RBV theory, R&D investment represents a strategic resource that is valuable, rare, and difficult for competitors to imitate, contributing to firm-specific advantages that improve market positioning and financial performance (Barney 1991). Given the inherent uncertainties associated with R&D investments and the JMF business model,[30] it becomes crucial to examine both elements closely.

Previous studies have predominantly explored the relationship between R&D and financial performance using mixed samples of generic firms, yielding mixed results, without specifically focusing on JMFs. Using a broad cross-section of industries may mask differences in relationships across industries, and an estimated average relationship across all industries may be the net result of widely differing relationships countervailing each other (Cui and Mak 2002). It is possible that different research settings might exhibit distinct valuation structures due to variations in growth potential, investment opportunities, and the informativeness of accounting figures. Consistently, many empirical studies support a positive association between R&D investment and firm performance, by measures including sales growth (Filatotchev and Piesse 2009), market value (Ehie and Olibe 2010), and investment opportunities (Borisova and Brown 2013). Conversely, some studies have reported contrary results (e.g., Majocchi and Zucchella 2003).

[30] Firm expenditure on R&D is a widely recognized proxy for innovation (Peters 2009), and I regard R&D activities as a prime mechanism for building a firm's knowledge base and innovation capabilities.

The mixed results observed in the literature indicate that the effect of R&D activities on firm performance may be conditional on how firm performance is measured and on firm-level and industry-level characteristics. While existing research offers a broad understanding of R&D investment impacts, it overlooks the nuances specific to different industries. This oversight is particularly evident in the mining industry, a field marked by unique fundamentals and severe uncertainty.

4.2.3. Anecdotes from Interviews

To better understand the relationship between R&D investment and firm valuation in JMFs, I conduct five semi-structured interviews with senior management from various JMFs. See Appendix 4.2 for interviewee details. The interviews were facilitated by the Minerals Research Institute of Western Australia (MRIWA) and followed ethical guidelines.[31] All held senior management roles and had experience in decision-making related to R&D investments within their respective organizations. The interviews were conducted individually with the respondents. I used a questionnaire to guide my semi-structured interviews.

These conversations surface several themes consistent with the theoretical arguments developed in Section 4.3. First, three respondents mentioned that engaging in R&D helps their firms develop project-specific technical knowledge that is tailored to their geological setting. For instance, one interviewee explained that their R&D efforts focused on testing and refining alternative extraction and processing options during project evaluation. Another key driver of JMFs' R&D investment, mentioned by two interviewees, was the acquisition of specialized knowledge to address complex geological and processing challenges. According to one Managing Director (Int1), "Understanding my deposits more deeply helps us optimize operations and plan for the long term." In the interviews, respondents used the term "operations"

[31] Ethical clearance for the study was granted by the University of Western Australia Ethics Committee (ref. ET000943).

broadly to describe project development and the planned mining and processing approach, rather than ongoing large-scale production. Additionally, environmental, social, and governance (ESG) considerations emerged as a prominent factor for JMFs, with two respondents pointing to increasing regulatory pressures and investor demand for sustainable practices as a motivation for undertaking R&D. As one Processing Manager (Int5) noted, “If there’s a better way of doing it that reduces costs but also has a significant environmental benefit, you go for it. You are always driven by financials, but increasingly, I are also driven by environmental factors and ESG.”

Despite these motivations, all respondents unanimously cited financial constraints as a significant barrier to JMFs’ R&D investment. JMFs often operate with limited cash reserves, which makes funding long-term initiatives like R&D challenging. Chief Operating Officer (Int2) explained, “For juniors, the barriers are always funding … and public interest … that’s part of the game. I fully endorse R&D—it’s all about funding and the applicability of that research to advance my projects.” Delays in receiving government R&D tax rebates further compound this challenge. A respondent (Int5) shared their experience of waiting nearly a year for a rebate, which they described as unsustainable given their tight cash flow. Beyond financial pressures, two respondents highlighted a lack of in-house expertise as an additional obstacle. R&D initiatives often require specialized technical knowledge, which these firms lack, forcing them to rely on external consultants, thus potentially increasing costs and slowing progress. As one director (Int1) noted, “We simply do not have the expertise to run sophisticated R&D programs internally, so I depend on external parties.”

The time-intensive nature of R&D was also identified by the interviewees as a barrier for JMFs, particularly in terms of its limited short-term impact on firm valuation. All participants acknowledged that while R&D may generate long-term benefits, it does not yield immediate financial returns or share price gains. One interviewee explained, “Unlike drilling results, R&D does not move the needle on my share price immediately. It may help me in the long run" (Int3). Nonetheless, four participants emphasised that successful R&D projects can enhance resource estimates and ultimately boost investor confidence. For example, better resource definitions achieved through R&D were described as a key factor in improving long-term valuation prospects, even if immediate impacts remain negligible. Moreover, tax incentives were noted as a vital support mechanism, with three participants highlighting the importance of these rebates in mitigating financial pressures. However, concerns over delayed processing times for rebates were consistently raised, further illustrating the financial vulnerabilities of these firms.

Taken together, the interviews reveal a complex interplay between the motivations and barriers associated with R&D investment in JMFs. While competitive advantage, knowledge acquisition, and ESG compliance drive R&D efforts, financial constraints, lack of expertise, and the delayed impact on valuation limit these initiatives. Tax incentives provide some relief but are insufficient to address the broader structural challenges faced by JMFs.

4.3. Hypothesis Development

Deciding whether to use accounting profit ratios or market valuation metrics as a measure of JMFs' performance is an important issue for this study. Previous research (e.g., Demsetz and Villalonga 2001; Shan and McIver 2011) highlights two main differences between accounting profit ratios, such as return on assets (ROA), and market valuation metrics, like Tobin's Q. Firstly, accounting profit ratios are retrospective, reflecting past management achievements and influenced by accounting practices. In contrast, Tobin's Q is prospective, capturing the market's valuation of a firm's current and future potential based on tangible and intangible assets. Secondly, the perspective from which performance is measured varies: accounting profits are determined within the framework of accounting standards, while Tobin's Q is influenced by investors' perceptions.

As noted previously, the traditional reliance on earnings-based measures is often inadequate for JMFs due to their unique business model, which centers on converting investment inflows into exploratory activities. These activities, such as acquiring mining tenements and prospecting, are inherently uncertain, with much of the capital not resulting in viable discoveries. As a result, accounting metrics like ROA may fail to capture the value generated through R&D. By contrast, Tobin's Q aligns more closely with the forward-looking nature of JMFs' value creation, making it a more suitable performance metric for JMFs.[32]

The RBV suggests that technical knowledge created through R&D can be a firm-specific asset that is hard for competitors to copy (Barney 1991). For JMFs, R&D is often directed at project-level problems such as improving resource definition, testing processing options, or meeting environmental requirements (Balci and Kumral 2022). These activities can increase expected project value and therefore firm value. In addition, because many JMFs have limited current revenue, R&D spending can carry information content for investors as a signal of project progress and managerial capability.

At the same time, R&D outcomes are uncertain, and payoffs may be delayed (Filippou et al. 2011; Hsu et al. 2013). For resource-constrained JMFs, R&D spending can also increase cash burns and raise concerns about future financing needs. Prior studies also suggest that the relation between R&D intensity and firm value can be non-linear and depend on firm and industry conditions (Ho et al. 2005; Minniti and Venturini 2017). These competing forces mean

[32] To provide a comprehensive analysis, this study also examines the relationship between R&D investment and accounting performance as a secondary measure in the additional test.

that the valuation effect of R&D in JMFs is not obvious ex ante, which motivates an empirical test.

Taken together, I expect that, on average, R&D intensity is positively associated with JMFs' firm value because it can add technical knowledge and credibility that support investors' expectations about future cash flows and financing prospects. This leads to the hypothesis:

Hypothesis. *Ceteris paribus*, higher R&D intensity is associated with increased firm value for JMFs in Australia.

4.4. Research Method

4.4.1. Model

To evaluate the effect of R&D investment on JMFs' firm valuation, I estimate the following OLS model using *Tobin's Q* as the dependent variable:

$$Tobin's\ Q_{it+3} = \beta_0 + \beta_1 R\&D\ Intensity_{it} + \beta_m \sum Control\ Variables\ + \sum \beta_k\ YEAR\ FE\ + \sum \beta_n\ SubIndustry\ FE + \varepsilon_{it,} \quad (1)$$

where i indexes firm, t indexes year, and ε is an error term. Consistent with prior studies (e.g., Fauver et al. 2017; Nam and Uchida 2019), I use *Tobin's Q* as the market-based indicator of firm value. As *Tobin's Q* reflects the market's evaluation of a firm's prospects when taking all the available information into account (Miller et al. 2015), it is a forward-looking, market-based measure of a firm's valuation. This measure well suits my research context for JMFs. Mathematically, *Tobin's Q* is calculated as total assets minus book value of equity, plus market value of equity, divided by book value of total assets. I measure a firm's R&D investments as its *R&D Intensity* (Ehie and Olibe 2010; Jacobs et al. 2016; Xia et al. 2016),[33] calculated as the

[33] I am mindful of the need to capitalize R&D since it is an investment in the intangible assets of a firm. However, IFRS rules say that research is generally all expensed. There are strict rules in general where development costs are capitalized. The evaluation and exploration standard IFRS 6 are an anomaly where evaluation and exploration costs are allowed to be capitalized - although they may not meet the asset definition. For reasons of parsimony

two-year average of the ratio of R&D expenditure to sales (Curtis et al. 2020). I relied on one proxy of R&D effort, namely R&D expenditure, rather than introducing the second popular proxy, patents, because past research has shown that there is a consistently strong correlation between R&D expenditure and patent counts (Yiu et al. 2007). I employ the natural logarithm of R&D expenditure as an alternative measurement in my robustness tests and obtain consistent results.

Prior studies have identified a time lag effect of R&D investment, due to the time required to transform R&D inputs into practical applications (e.g., Hirschey and Weygandt 1985; Ernst 2001; Curtis et al. 2020). Eberhart et al. (2004) show that there is a certain number of years needed for the correction of the market mispricing and therefore it can be characterized as a slow process. To be able to examine the lagged effect of R&D investment on JMFs' performance in a regression model, a plausible time period had to be defined a priori in which these lagged effects could be reflected. Findings drawn from the literature and results of studies on similar subjects could be used to assume a lag of up to 5 years (Gomes-Casseres et al. 2006; Schilling 2015). I thus focus on a 3-year lag (*t+3*) in my main analyses and also use different year-lag structures, up to 5 years after the R&D investment, between the dependent and independent variables to capture the time-lag effect on R&D activities.

I follow prior research and include a host of control variables, such as firm size (*SIZE*), leverage (*LEV*), asset tangibility (*PPE*), inventory level (*INVENTORY*), adjusted ROA (ROA^{Adj}), capital expenditure (*CAPEX*), and intangible assets (*INTANG*). As firm size is a significant predictor of firm performance (e.g., Hendricks and Singhal 2003), I first control firm size (*SIZE*) and measure it as the natural logarithm of total assets (Modi and Mishra 2011). The firm's leverage (*LEV*) is calculated as total debt divided by total assets. Firms with a higher

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and the inability to have an economically driven amortization rate, following prior studies (e.g., Ho et al. 2005), I use R&D expenditure to sales instead of the capitalized R&D to sales as a measure of R&D intensity.

leverage might be more capable of capitalizing on external financial resources to enhance their returns (Bae et al. 2017). I include asset tangibility (*PPE*), calculated as the ratio of property, plant, and equipment to total assets, because firms with a greater proportion of tangible assets have fewer value-generating intangible assets. I then control for a JMF's inventory level (*INVENTORY*), which is measured as inventory scaled by total assets. Additionally, a JMF's accounting performance is included. Following prior studies (e.g., Curtis et al.2020), I adjust income by adding back R&D expense to get adjusted ROA (hereafter ROA^{Adj}). Thus, future values of net income are not mechanically reduced by future R&D expenditure. Finally, given that firms' new investments positively affect firm valuation and performance (Gamayuni 2015; Aggarwal et al. 2019), I control for the ratio of capital expenditure to total assets (*CAPEX*) and the ratio of intangible assets to total assets (*INTANG*). Appendix 4.1 provides detailed variable definitions.

Finally, I include year fixed effects and sub-industry fixed effects to control for the within-year (*YEAR FE*) and within-sub-industry (*SubIndustry FE*) change in the outcome variable. Following Breuer and DeHaan (2024), I compute and compare the average within-firm R&D expense change and find it is significantly smaller than the average between-firm change for these JMFs. Specifically, the average within-firm R&D expense change, calculated as the mean range of R&D expenses for each firm from 2000 to 2019, is 0.040, while the average between-firm R&D expense change, calculated as the mean absolute difference between each firm's R&D range and the sub-industry R&D range, is 0.802. According to Breuer and DeHaan (2024), the firm fixed effect, which eliminate between-firm variation, is unsuitable when between-group variation carries greater explanatory power. Thus, to ensure both theoretical consistency and data-driven analysis, I do not control for the firm fixed effect in this study.

4.4.2. Sample and entropy balancing method

This study traces the R&D intensity and firm valuation of a panel of the junior mining firms listed on the Australian Securities Exchange (ASX) from 2000 to 2019. Annual accounting and financial data are collected from Compustat. The firms operating in the mining industry are identified using the Global Industry Classification Standard (GICS) code.[34] To focus on the junior mining firms in Australia, the sample is limited to firms that are legally incorporated in Australia (FIC), and whose market capitalization is equal to or less than AUD 500 million (ASIC 2006). This size-based definition captures the junior segment and can include firm-years at different points in the mining project cycle, including exploration, development, and early production. To control for the bias in R&D disclosure and to preserve the sample size, following previous studies (e.g., Koh et al. 2018), I retain observations with missing R&D expenditure data, and replace the missing R&D expenditure with zero.[35] The final sample consists of 7,434 firm-year observations, of which 244 have engaged in R&D investment. This sample reflects the use of *Tobin's Q* measured at the three-year forward horizon (t+3). Observations for fiscal years 2020-2022 are therefore excluded due to an insufficient future window. Sample sizes vary across analyses depending on the forward horizon examined. For instance, the persistence tests in Table 4.4, which extend the horizon to *t+1*, *t+2*, *t+4*, and *t+5*, yield different sample sizes, as shorter horizons retain more recent observations while longer horizons require additional future years of data and are subject to greater sample attrition from delistings. The step-by-step sample construction process for the main analysis is reported in Appendix 4.3.

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[34] GICS is a four-tiered, hierarchical industry classification system used globally for categorizing public firms. It consists of sectors, industry groups, industries, and sub-industries. The specific code 151040 represents the Metals & Mining industry, and covers firms from seven sub-industries, including Aluminum (15104010), Diversified Metals & Mining (15104020), Copper (15104025), Gold (15104030), Precious Metals & Minerals (15104040), Silver (15104045), and Steel (15104050).

[35] In untabulated results, I exclude the observations with missing values of R&D expenditure in each regression. The coefficients increase, while the significance become relatively small compared to the full sample. This reduction in sample size could influence the inferences because missing observations are not exogenously determined and whether observations have missing future years could relate to a firm's R&D investment (Curtis et al., 2020). The inferences remain unchanged.

A firm's involvement in R&D investment is not random (Cho and Lee, 2021). I follow prior studies and apply entropy balancing as a preprocessing technique to achieve covariate balance within a binary treatment – that is, having invested in R&D (*R&D_Dummy* = 1) in my case (Hainmueller 2012; McMullin and Schonberger 2018; Kuang et al. 2021).[36] The control group consists of non-R&D expenditure incurring observations (*R&D_Dummy* = 0). Panel A in Table 4.1 reports the distribution of R&D engagement in my sample by year. I implement entropy balancing by adjusting inequalities in the covariate distributions with respect to the first (mean), second (variance), and third (skewness) moments. Panel B of Table 4.1 reports the descriptive statistics regarding the covariate distributions of entropy balancing, both in the full sample and after applying entropy balancing with *R&D_Dummy* as the treatment and adjusting on the three moments. Further, I notice that all three moments of the covariates between R&D investment engaging and non-R&D expenditure incurring observations are similar after entropy balancing, suggesting the effectiveness of my method in achieving a sufficient balance between the treatment and control groups.

4.4.3. Descriptive Statistics

Panel C of Table 4.1 presents the descriptive statistics for the main regression sample (N = 7,434, before entropy balancing) for all variables used in the main regression analyses and supports my argument that the JMFs have distinct firm characteristics. To alleviate the potential impact of outliers, all continuous variables are winsorized at the first and ninety-ninth percentiles. The mean firm value (*t+3*) stands at 4.302, while ROA^{Adj} has a mean of –0.535, with an average adjusted net income of –3.568 million AUD. Consistent with earlier

[36] As explained by Hainmueller (2012, 26), entropy balancing "involves a reweighting scheme that directly incorporates covariate balance into the weight function that is applied to the sample units" and "searches for the set of weights that satisfied the balance constraints [prespecified] but remains as close as possible (in an entropy sense) to a set of uniform base weights to retain information." By recalibrating unit weights using entropy balancing, I can effectively adjust for "systematic and random inequalities in representation" without sacrificing observations (Hainmueller 2012 26).

discussions, JMFs typically face significant initial expenses for exploration, evaluation, and development of mining projects. These activities are capital-intensive and often extend over several years. Until a mine becomes operational and begins producing and selling minerals, JMFs usually have limited or no revenue. However, they continue to incur costs for exploration, administration, and project development. These expenditures are often expensed immediately according to accounting standards, further contributing to negative net income. This observation aligns with findings from previous mining studies in other countries (e.g., Rafiq et al. 2016). The positive Tobin's Q and the negative adjusted ROA imply that accounting-based profitability is not the key consideration in the valuation of JMFs.

From the summary statistics it can also be observed that the average R&D intensity among the sample is 1.4%, with a notable number of JMFs not engaging in R&D investment. The mean values of leverage, asset tangibility, inventory level, and capital expenditure of the sample firms are 2.5%, 49.3%, 1.3%, and 13.8%, respectively. The average total assets of sample firms amount to 8.82 million AUD,[37] with intangible assets comprising 2% of total assets. These findings are comparable with those of prior industry specific studies on firm value (e.g., Ehie and Olibe 2010; Jacobs et al. 2016) and R&D effects studies (e.g., Cui and Mak 2002).

4.4.4. Multivariate Analyses

Tests are conducted for the possible existence of multicollinearity. The first is an informal test that follows Gujarati (2003), who argues that correlations between the independent variables should not be deemed harmful for multivariate analysis unless they exceed 0.8. As shown in Table 4.2, no Pearson correlation coefficient approaches this threshold. Furthermore, as multicollinearity can arise when one independent variable is a linear function of a combination

[37] Table 4.1 Panel C reports mean *SIZE* = 15.992; since *SIZE* is the natural logarithm of total assets, exp(15.992) is approximately 8.82 million.

of others (Gujarati 2003), I also assess its presence using the Variance Inflation Factor (VIF). The analysis shows that the largest VIF is 1.57 and that the average of the VIF values for the variables is 1.21, which is close to 1. Thus, there is no evidence of a serious multicollinearity problem being present in the regression model.

Table 4.1. Descriptive statistics.

Panel A: Sample distribution by year

Year	*R&D_Dummy* = 0	*R&D_Dummy* = 1	Total
2000	71	8	79
2001	105	6	111
2002	167	12	179
2003	182	11	193
2004	210	10	220
2005	235	12	247
2006	298	17	315
2007	363	15	378
2008	447	13	460
2009	456	18	474
2010	488	14	502
2011	479	13	492
2012	503	12	515
2013	495	13	508
2014	475	12	487
2015	452	13	465
2016	440	10	450
2017	455	13	468
2018	452	11	463
2019	417	11	428
Total	**7,190**	**244**	**7,434**

Panel B: Descriptive statistics – the covariate distributions of entropy balancing

	Before entropy balancing						After entropy balancing					
	R&D_Dummy = 1			*R&D_Dummy* = 0			*R&D_Dummy* = 1			*R&D_Dummy* = 0		
	mean	variance	skewness	mean	variance	skewness	mean	variance	skewness	mean	variance	skewness
SIZE	16.241	3.183	0.620	15.984	2.281	–0.123	16.241	3.183	0.620	16.241	3.183	0.620
LEV	0.057	0.020	3.137	0.024	0.008	5.191	0.057	0.020	3.137	0.057	0.020	3.137
PPE	0.262	0.090	1.007	0.501	0.109	–0.214	0.262	0.090	1.007	0.262	0.090	1.007
INTANG	0.101	0.038	2.194	0.018	0.009	6.178	0.101	0.038	2.194	0.101	0.038	2.194
INVENTORY	0.061	0.008	1.498	0.011	0.002	5.169	0.061	0.008	1.498	0.061	0.008	1.498
ROA^{Adj}	–0.485	1.228	–4.815	–0.536	1.473	–4.770	–0.485	1.228	–4.815	–0.485	1.228	–4.815
CAPEX	0.060	0.012	3.908	0.140	0.029	2.058	0.060	0.012	3.908	0.060	0.012	3.908

Panel C: Descriptive statistics before entropy balancing for all main variables

Variable	*N*	Mean	SD	Min	Max	P25	P50	P75
Tobin's Q_{t+3}	7,434	4.302	10.367	0.159	94.790	0.784	1.515	3.402
R&D intensity	7,434	0.014	0.102	0.000	0.857	0.000	0.000	0.000
SIZE	7,434	15.992	1.521	11.513	20.177	15.133	15.985	16.867
LEV	7,434	0.025	0.093	0.000	0.678	0.000	0.000	0.000
PPE	7,434	0.493	0.331	0.000	0.987	0.164	0.542	0.792
INTANG	7,434	0.021	0.101	0.000	0.720	0.000	0.000	0.000
INVENTORY	7,434	0.013	0.046	0.000	0.310	0.000	0.000	0.000
ROA^{Adj}	7,434	–0.535	1.210	–8.753	0.406	–0.489	–0.176	–0.064
CAPEX	7,434	0.138	0.170	0.000	0.926	0.009	0.080	0.206

Notes: Panel A reports the sample distribution by year. Panel B reports the descriptive statistics regarding the covariate distributions of entropy balancing. Panel C reports the descriptive statistics before entropy balancing for all main variables. *Tobin's Q* is measured at the three-year forward horizon (*t+3*). Variable definitions are provided in Appendix 4.1.

Table 4.2. Correlation Matrix.

	Tobin's Q	*R&D Intensity*	*SIZE*	*LEV*	*PPE*	*INTANG*	*INVENTORY*	*ROA^{Adj}*	*CAPEX*
Tobin's Q_{t+3}	1.000								
R&D Intensity	0.050***	1.000							
SIZE	–0.233***	–0.051***	1.000						
LEV	0.059***	0.013	0.108***	1.000					
PPE	–0.090***	–0.095***	0.318***	0.054***	1.000				
INTANG	–0.003	0.085***	0.035***	0.053***	–0.228***	1.000			
INVENTORY	–0.020*	0.092***	0.273***	0.152***	–0.111***	0.058***	1.000		
ROA^{Adj}	–0.183***	–0.021*	0.474***	–0.041***	0.189***	0.027**	0.067***	1.000	
CAPEX	0.025**	–0.063***	–0.042***	0.012	0.168***	–0.068***	–0.058***	–0.199***	1.000

Notes: This table presents the correlation matrix. All of the variables are defined in Appendix 4.1. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

4.5. Results

4.5.1. Main Results

The regression analysis presented in Table 4.3 examines the effects of R&D investment on JMFs' firm valuation. Column (1) reports the results of a base model without including control variables; Column (2) exhibits the results of the model (1) before entropy balancing, while Column (3) shows the results of the model (1) after entropy balancing. I first compare the goodness of fit across the models (Kuang et al., 2021). The results show that, relative to the base model, adding control variables in Column (2) significantly improves the explanatory power of the model (*Adjusted* R^2 =0.096), which is further improved by applying the entropy balanced sample in Column (3) (*Adjusted* R^2 =0.122).

Next, I examine the coefficients of R&D investment. The significantly positive coefficients on *R&D Intensity* across all columns (p-value < 0.05) are in line with expectation, and suggest that JMFs with higher R&D intensity have better firm valuation. Specifically, when control variables are not included, a one-unit increase in *R&D Intensity* is associated with an average increase in *Tobin's Q* of 5.147. As shown in Column (2), after adding controls, the effect decreases to 3.765, and in the entropy balanced sample (Column 3), the effect remains at 3.677. A one-standard-deviation increase in *R&D Intensity* raises *Tobin's Q* by approximately 8.94% in Column (2) and 8.73% in Column (3) relative to its average value of 4.302. In Column (3), using SD (*R&D Intensity*) = 0.102 from Table 4.1 Panel C, the estimate implies approximately 0.38 higher *Tobin's Q* in year $t + 3$ for a one-standard-deviation increase in *R&D Intensity*. Under the definition of *Tobin's Q*, and holding total assets and book value of equity constant, this corresponds to about 3.35 million AUD higher market value of equity, where 8.82 million is the implied sample mean total assets, derived from the mean *SIZE* reported in Table 4.1 Panel C as exp(15.992).

Regarding control variables after entropy balancing, I note that *SIZE*, *LEV*, and *ROA*^{Adj} are negatively related to *Tobin's Q*. Other control variables, including *PPE*, *INTANG*, *INVENTORY*, and *CAPEX*, show no significant impact. The results on the control variables are consistent with prior studies (e.g., Donelson et al. 2011; Curtis et al. 2020). These findings suggest that increasing R&D investment relative to sales significantly boosts market perceptions of firm value for JMFs. However, the duration and exact path of the effect remain to be tested.

Table 4.3. The Effect of R&D Investment on JMFs' Valuation.

	Dependent variable: *Tobin's* Q_{it+3}		
	(1)	(2)	(3)
Variable	Without Controls	OLS Full Sample	Entropy Balanced Sample
R&D Intensity	**5.147*****	**3.765****	**3.677****
	(2.648)	**(2.442)**	**(2.005)**
SIZE		–1.419***	–1.301***
		(–12.077)	(–5.301)
LEV		8.133***	–4.958*
		(3.015)	(–1.934)
PPE		–0.614	0.176
		(–1.398)	(0.140)
INTANG		–0.376	1.918
		(–0.365)	(0.650)
INVENTORY		5.563*	12.565
		(1.745)	(1.607)
ROA^{Adj}		–0.626***	–0.793*
		(–3.063)	(–1.719)
CAPEX		1.019	3.023
		(1.002)	(1.464)
Constant	4.229***	27.399***	27.260***
	(23.714)	(10.845)	(5.201)
N	7,434	7,434	7,434
Adjusted R-squared	0.032	0.096	0.122
Year fixed effect	YES	YES	YES
Sub-industry fixed effect	YES	YES	YES

Notes: This table reports the OLS regression results of the association between *R&D Intensity* and JMFs' firm value, where firm value is measured as *Tobin's Q* in year t + 3. The t-statistics are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels (two-tailed), respectively. Variable definitions are provided in Appendix 4.1.

Next, I examine how long the effect of R&D investment on increased firm value will persist. Specifically, I regress the string of *Tobin's Q* for the years $t + 1$ to $t + 5$ on *R&D Intensity*. Table 4.4 presents the results, which show a statistically significant increase in Tobin's Q associated with R&D intensity at the two-year lag structure, and a marginally significant effect at the four-year lag. Specifically, *R&D Intensity* shows a significant association with *Tobin's Q* at a two-year lag 4.284 ($p = 0.043$) and a marginally significant association at a four-year lag 4.044 ($p = 0.077$), while no significant effects are observed for a one-year ($\beta_1 = 1.801$, $p = 0.296$) or a five-year lag ($\beta_1 = 3.344$, $p = 0.134$). The evidence thus suggests that the positive effect of R&D investment on JMFs' firm value spans three years, from the 2- to 4-year lag structures. The insignificant effect at the 1-year lag structure suggests that the market perceives R&D investments as risky in the short term.[38] Additionally, the impact appears to diminish beyond the two-year lag, indicating a decreasing association between R&D investments and future market benefits over time, which is consistent with previous studies (e.g., Dichev and Tang 2008; Donelson et al. 2011; Curtis et al. 2020). These findings further confirm that R&D intensity has a positive effect on JMFs' firm value.

To summarize, my results show that R&D intensity is positively associated with JMFs' firm valuation. This finding holds across all model specifications, with significantly positive coefficients on R&D intensity. Furthermore, my analysis on different lag structures reveals that the positive effects of R&D intensity on firm valuation broadly persist from the 2- to 4-year lag structures, with the strongest evidence at the two-year horizon. These results suggest that the benefits of R&D investment generally materialize over an extended period, and the market does not instantly recognize the future value of current R&D outlays.

[38] R&D projects carry inherent risks due to the uncertain outcomes of exploring new technologies or processes (Hsu et al. 2013); financial returns are often delayed as benefits like improved efficiency or new product development emerge over time, and a certain number of years is needed for the correction of market mispricing (Eberhart et al. 2004).

Table 4.4. How Long the Effect of R&D Investment on Increased Firm Value Persists.

	Entropy Balanced Sample			
Variable	(1) *Tobin's* Q_{it+1}	(2) *Tobin's* Q_{it+2}	(3) *Tobin's* Q_{it+4}	(4) *Tobin's* Q_{it+5}
R&D Intensity	**1.801**	**4.284****	**4.044***	**3.344**
	(1.045)	**(2.025)**	**(1.773)**	**(1.500)**
SIZE	–1.135***	–1.024***	–1.446***	–1.537***
	(–3.209)	(–3.243)	(–4.219)	(–4.351)
LEV	–1.148	–1.004	2.842	8.404
	(–0.341)	(–0.267)	(0.628)	(1.376)
PPE	0.960	0.906	0.518	0.772
	(0.617)	(0.626)	(0.238)	(0.288)
INTANG	–2.956**	1.421	0.041	0.240
	(–2.064)	(0.580)	(0.017)	(0.095)
INVENTORY	9.610	3.815	11.750	5.196
	(1.244)	(0.601)	(0.896)	(0.576)
ROA^{Adj}	–1.973	–1.664	0.325	–0.138
	(–1.621)	(–1.360)	(0.973)	(–0.209)
CAPEX	–3.873	–4.519	0.752	–2.562
	(–0.980)	(–0.992)	(0.396)	(–0.855)
Constant	20.935***	19.541***	26.714***	28.394***
	(3.473)	(3.609)	(5.206)	(5.179)
N	7,291	7,307	6,547	5,809
Adjusted R–squared	0.157	0.134	0.113	0.147
Year fixed effect	YES	YES	YES	YES
Sub–industry fixed effect	YES	YES	YES	YES

Notes: This table reports the persistence of R&D investment effects on firm value across *t+1*, *t+2*, *t+4*, and *t+5* horizons. Sample sizes differ from the main regression (N = 7,434) as each horizon requires a different number of post-period years, with shorter horizons retaining more observations and longer horizons subject to greater attrition. The *t*-statistics are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels (two-tailed), respectively. Variable definitions are provided in Appendix 4.1.

4.5.2. Robustness Tests

The R&D intensity measure is based on R&D expenditure of the firm over a two-year period including the sample year and the preceding 1 year, which can mitigate the reverse causality concern. To mitigate the omitted variable concern, as a falsification test, I follow prior research (e.g., Kuang et al. 2021) and lag *Tobin's Q* of Model (1) by 1 year and re-run the regression. Results in Table 4.5 show that the current R&D intensity does not have a significant association with *Tobin's Q* in year $t - 1$, which suggests that it is less likely that my main findings on *Tobin's Q* are because of a correlated omitted variable problem.

Table 4.5. Falsification Test.

	Dependent variable: *Tobin's* Q_{it-1}		
	(1)	(2)	(3)
Variable	Without Controls	OLS Full Sample	Entropy Balanced Sample
R&D Intensity	**–0.062**	**–0.985**	**1.589**
	(–0.041)	**(–0.656)**	**(0.882)**
SIZE		-0.654^{***}	-0.430^{***}
		(–5.344)	(–2.919)
LEV		–0.296	0.728
		(–0.359)	(0.608)
PPE		-5.834^{***}	-5.035^{***}
		(–10.808)	(–4.588)
INTANG		-5.520^{***}	–0.878
		(–4.122)	(–0.311)
INVENTORY		-14.435^{***}	-13.620^{***}
		(–7.715)	(–4.413)
ROA^{Adj}		0.140	–0.005
		(0.773)	(–0.014)
CAPEX		2.333^{***}	6.849^{**}
		(2.637)	(2.418)
Constant	4.686^{***}	18.339^{***}	12.774^{***}
	(28.972)	(9.084)	(5.226)
N	7,661	7,661	7,661
Adjusted R–squared	0.040	0.081	0.070
Year fixed effect	YES	YES	YES
Sub–industry fixed effect	YES	YES	YES

Notes: This table reports the results of the falsification test. The sample is restricted to 2000-2019, consistent with the main regression, and excludes 2020-2022 observations. Sample sizes differ from the main regression (N = 7,434) as the falsification test uses *Tobin's Q* at *t - 1* as the dependent variable, which retains observations that lose the three-year forward window required in the main regression. *t*-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels (two-tailed), respectively. Variable definitions are provided in Appendix 4.1.

I further conduct a DID approach to address the endogeneity issues. Specifically, I use the introduction of the 2012 Australian R&D Tax Incentive as a quasi-natural experiment that generated a positive shock to R&D investment among eligible firms. This tax incentive, established under the *Income Tax Assessment Act 1997 (Division 355)* and the *Industry Research and Development Act 1986 (Part III)*, replaced the previous R&D Tax Concession program. It introduced a refundable tax offset for firms with aggregated turnover below AUD 20 million and a non-refundable tax offset for larger firms, thereby significantly altering the financial landscape for R&D activities. The policy aimed to encourage business innovation by reducing the after-tax cost of R&D expenditure, particularly for smaller firms. Thus, this legislative change serves as an exogenous event that allows us to evaluate the causal impact of increased R&D incentives on smaller mining firms' valuation.

$$Tobin\ Q_{it} = \gamma_0 + \gamma_1 Treat + \gamma_2 Post + \gamma_3 Treat \times Post + \gamma_m$$
$$\sum Control\ Variables + \sum \gamma_k\ YEAR\ FE + \sum \gamma_n\ SubIndustry\ FE + \varepsilon_{it,} \qquad (2)$$

The treatment firms are defined as mining firms involved in an R&D project with annual revenue below AUD 20 million, which makes them eligible for the refundable R&D tax offset. The control group consists of mining firms with no R&D investments and/or firms with annual revenue above AUD 20 million, which were only eligible for the non-refundable tax offset. I construct two key indicators: *Treat*, an indicator for treatment firms, and *Post*, an indicator for the post-policy period (i.e., years from 2012 onward). The interaction term *Treat* × *Post* captures the differential impact of the R&D Tax Incentive on *Tobin's Q*. The significantly positive coefficient ($\gamma_3 = 3.604$, $p < 0.021$) on *Treat* × *Post* in Column (1) of Table 4.6 suggests that the 2012 R&D Tax Incentive had a substantial positive effect on the market valuation of JMFs that benefited from the refundable tax offset. It provides further evidence that the market recognizes the value-enhancing role of R&D investment, particularly for firms incentivized to invest in innovation through targeted policy measures, reinforcing my baseline results.

As an alternative method to address endogeneity concerns, I adopt the PSM approach. Specifically, I estimate the propensity scores using a logistic regression, where the treatment indicator (*R&D_dummy*) —a dummy variable that equals one if a JMF engaged in R&D and zero otherwise—is regressed on firm-level characteristics, including firm size (*SIZE*), leverage (*LEV*), asset tangibility (*PPE*), inventory level (*INVENTORY*), adjusted ROA (ROA^{Adj}), capital expenditure (*CAPEX*), and intangible assets (*INTANG*). Matching is performed within each year from 2000 to 2019 using 10 nearest neighbors and a caliper of 0.025 to ensure balance between the treatment and control groups. Weights derived from the matching process are then applied to re-estimate the relationship between *R&D Intensity* and *Tobin's Q* using a weighted regression model with year and sub-industry fixed effects. Column (2) of Table 4.6 presents the results. The significantly positive coefficient on *R&D Intensity* confirms that higher R&D intensity is associated with improved firm valuation, consistent with my primary findings.

Table 4.6. Two Tests to Address Endogeneity Issues.

	Entropy Balanced Sample	PSM Sample
	(1)	(2)
Variable	*Tobin's* Q_{it}	*Tobin's* Q_{it+3}
Post × Treat	**3.604****	
	(2.318)	
Treat	–3.522***	
	(–2.974)	
R&D Intensity		**3.623****
		(2.251)
SIZE	–2.918***	–1.218***
	(–13.529)	(–4.560)
LEV	6.482***	9.095*
	(3.051)	(1.769)
PPE	–1.246**	0.637
	(–2.383)	(0.772)
INTANG	–0.912	1.107
	(–0.528)	(0.770)
INVENTORY	11.813***	4.414

	(3.285)	(0.894)
ROA^{Adj}	-2.464^{***}	–0.890
	(–7.623)	(–1.571)
CAPEX	0.008	–1.207
	(0.007)	(–0.699)
Constant	50.495^{***}	21.001^{***}
	(14.462)	(4.572)
N	7,434	1,754
Adjusted R–squared	0.313	0.090
Year fixed effect	YES	YES
Sub–industry fixed effect	YES	YES

Notes: This table reports two tests to address endogeneity issues. Column (1) presents the results of DID test. Specifically, I use the introduction of the 2012 Australian R&D Tax Incentive as a quasi-natural experiment that generated a positive shock to R&D investment among eligible firms. *Treat* is an indicator equals to one for junior mining firms engaged in R&D projects with annual revenue below AUD 20 million, making them eligible for the refundable R&D tax offset, and zero otherwise. *Post* equals one for years from 2012 onward. Year fixed effects absorb *Post*. Column (2) presents the results using PSM approach. Matching is performed within each year from 2000 to 2019 using 10 nearest neighbors and a caliper of 0.025. The t-statistics are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels (two-tailed), respectively. Variable definitions are provided in Appendix 4.1.

As further robustness checks, Table 4.7 presents results using alternative dependent variables, independent variables, and sample periods, all estimated on the entropy-balanced sample. Column 1 replaces *Tobin's* Q_{t+3} with the market-to-book (M/B_{t+3}) ratio as the measure of firm value. The coefficient on *R&D Intensity* remains significantly positive (5.610, p = 0.056), suggesting that the positive association between R&D investment and firm valuation is not sensitive to the choice of value metric. Column 2 retains *Tobin's* Q_{t+3} as the dependent variable but replaces *R&D Intensity* with the natural logarithm of *R&D expenditure* as an alternative measure of R&D activity. The positive and significant coefficient (0.129, $p = 0.081$) indicates that the results are not driven by the specific construction of the R&D proxy. Column 3 mitigates the concern that the 2007–2008 global financial crisis may have confounded both R&D investment decisions and firm valuations. Excluding observations for fiscal years 2008 and 2009, the coefficient on *R&D Intensity* remains significantly positive (3.557, $p = 0.051$), showing that the main findings are not attributable to the crisis period.

Table 4.7. Alternative Dependent Variable, Independent Variable, and Sample.

	Entropy Balanced Sample	Entropy Balanced Sample	Entropy Balanced Sample
	(1)	(2)	(3)
Variable	M/B_{it+3}	*Tobin's* Q_{it+3}	*Tobin's* Q_{it+3}
R&D Intensity	**5.610***		**3.557****
	(1.913)		**(1.962)**
R&D Expenditure		**0.129***	
		(1.748)	
SIZE	–1.418***	–1.484***	–1.296***
	(–3.831)	(–4.877)	(–5.341)
LEV	–0.539	–5.419*	–5.488*
	(–0.155)	(–1.872)	(–1.869)
PPE	–4.123**	0.552	0.091
	(–2.207)	(0.407)	(0.067)
INTANG	–2.237	1.189	–0.030
	(–0.691)	(0.396)	(–0.012)
INVENTORY	2.539	13.194	14.116
	(0.324)	(1.415)	(1.596)
ROA^{Adj}	–0.631	–0.642	–1.195**
	(–0.971)	(–1.610)	(–2.267)
CAPEX	11.820	2.685	1.477
	(1.622)	(1.089)	(0.683)
Constant	27.969***	27.173***	27.021***
	(4.444)	(6.077)	(5.185)
N	7,053	7,426	6,500
Adjusted R–squared	0.162	0.118	0.132
Year fixed effect	YES	YES	YES
Sub–industry fixed effect	YES	YES	YES

Notes: This table reports robustness checks using alternative dependent variables, independent variables, and sample periods. All three columns are estimated on the entropy-balanced sample. Sample sizes vary across columns due to differences in data availability and sample restrictions. Column (1) replaces *Tobin's Q* with the *M/B* ratio as the dependent variable. Column (2) retains *Tobin's Q* as the dependent variable but replaces *R&D Intensity* with *R&D Expenditure*. Column (3) excludes fiscal years 2008 and 2009 to mitigate the influence of the global financial crisis on R&D investment and firm valuations. t-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels (two-tailed), respectively. Variable definitions are provided in Appendix 4.1.

Finally, I examine the relationship between R&D intensity and JMFs' accounting-based performance using different time-lag structures, and utilize ROA^{Adj} as the dependent variable. ROA^{Adj} is calculated by adding back R&D expenditure to net income, ensuring that the metric reflects the operational performance of firms without mechanically reducing earnings by R&D outlays. The untabulated results show a significant negative association between *R&D Intensity* and ROA^{Adj} in the third and fourth lag periods, while the association becomes insignificant by the fifth lag. These findings confirm that accounting metrics like ROA tend to fail to capture JMFs' value generated through R&D due to their unique nature.

4.6. Additional Analyses

4.6.1. Moderating Factors

Multinational Operations

The interview respondents highlighted that multinational firms tend to have greater access to international networks and resources, which could amplify the benefits of R&D investment. Meanwhile, JMFs engaged in multinational operations often face heightened operational complexities, including navigating diverse regulatory environments and managing cross-border risks. These complexities could influence the association between R&D investment and firm valuation. Motivated by these insights, I assess the moderating effect of multinational operations, and introduce *MULTI*, an indicator variable that equals one if the JMF reports non-zero international operating income, and zero otherwise. To examine this, I divide the sample into firms with and without multinational operations and rerun the main model with these subsamples.

Columns (1) and (2) of Table 4.8 report the results. For firms with multinational operations (*MULT* = 1), the coefficient of *R&D Intensity* is significantly positive ($\beta_1 = 6.713$, $p < 0.10$), indicating that R&D investments create substantial value in these firms. However, for firms without multinational operations (*MULT* = 0), the coefficient on *R&D Intensity* ($\beta_1 = 2.517$, $p > 0.10$) is smaller and insignificant. These findings suggest that multinational operations amplify the positive effect of R&D intensity on JMFs' firm valuation. This amplification is likely driven by opportunities for innovation diffusion across markets, enhanced global market access, and resource optimization, as noted in the interview insights.

The difference between the two groups is statistically significant at the 10 percent level (p = 0.082).

Agency Costs

Next, I examine whether agency costs moderate the association between R&D intensity and firm valuation. Insights from the interviews highlighted several concerns related to this issue. For example, one interviewee expresses challenges in aligning board and managerial support with long-term research goals due to fluctuating shareholder bases and short-term financial pressures. Others emphasised that agency costs, manifested through misaligned incentives, could hinder the strategic deployment of R&D resources, limiting their potential benefits. These insights are supported by prior literature (e.g., Le et al. 2006; Chan et al. 2015). For instance, Chan et al. (2015) show that firms with strong governance are better able to prevent overinvestment in R&D and increase the returns on these investments. Thus, I classify JMFs into high and low agency cost groups using the median value of selling, general and administrative expenses scaled by total revenues (*Agency Cost*).

Columns (3) and (4) of Table 4.8 report the results for low and high agency cost groups, respectively. For firms with low agency costs, the coefficient on *R&D Intensity* is significantly positive (β_1 = 10.548, $p < 0.05$), indicating that effective governance and lower managerial frictions facilitate the realization of R&D value. In contrast, for firms with high agency costs, the coefficient on *R&D Intensity* (β_1 =2.741) is insignificant, suggesting that misaligned managerial actions and governance inefficiencies dilute the market valuation benefits of R&D investments. I note that, although sizeable, the difference between the coefficients on the *R&D Intensity* is not statistically significant at conventional levels (p = 0.107). Nevertheless, the results highlight the critical role of governance and managerial incentives in shaping the value creation potential of R&D investments in JMFs.

Financial Distress (Z-Score)

Finally, as interview insights suggest that JMFs under financial strain may deprioritize long-term R&D investments due to immediate liquidity concerns, thereby limiting the value creation potential of R&D, I investigate whether financial distress moderates the relationship between R&D intensity and firm valuation. Consistent with existing literature (e.g., Altman 1968; Shan et al. 2024), the accounting-based financial distress is used as a measure of financial status.

The Altman Z-score is constructed as follows and can be interpreted as the higher the score, the better the financial status:

$$Distress = 1.2 \times \frac{Working\ Capital}{Total\ Assets} + 1.4 \times \frac{Retained\ Earnings}{Total\ Assets} + 3.3 \times \frac{Earnings\ before\ Interest\ and\ Taxes}{Total\ Assets} + 0.6 \times \frac{Market\ Value\ of\ Equity}{Total\ Liabilities} + 0.999 \times \frac{Sale}{Total\ Assets} \tag{3}$$

Due to the limited availability of year-end closing price data covered by Compustat Global, the sample for the $Distress$ analysis is smaller than the sample used for the main analysis. Columns (5) and (6) of Table 4.8 present the results for low and high financial distress JMFs, respectively. The coefficient on *R&D Intensity* is positive and significant for low distress JMFs (β_1 = 2.755, $p < 0.10$), while it is larger and more significant for high distress JMFs (β_1 = 4.732, not significant). The difference between the two groups is statistically significant. This finding aligns with insights from the interviews, where participants emphasised that financial distress often forces JMFs to prioritize short-term survival over strategic investments, thereby diminishing the long-term value generated by R&D.

Table 4.8. Moderating Factors.

	Dependent variable: *Tobin's* Q_{it+3}					
	Entropy Balanced Sample					
	(1)	(2)	(3)	(4)	(5)	(6)
Variable	*MULTI* = 1	*MULTI* = 0	Low *Agency Cost*	High *Agency Cost*	Low *Distress*	High *Distress*
R&D Intensity	**6.713***	**2.517**	**10.548****	**2.741**	2.755*	4.732
	(1.732)	**(1.271)**	**(2.178)**	**(0.740)**	(1.928)	(1.518)
SIZE	–1.167**	–1.398***	–0.916***	–1.976**	–0.691***	–1.816***
	(–2.396)	(–5.680)	(–3.018)	(–2.100)	(–3.484)	(–5.357)
LEV	–6.081	–5.389**	–4.044	–8.071*	0.171	12.666***
	(–1.463)	(–1.978)	(–1.469)	(–1.729)	(0.132)	(3.038)
PPE	3.655	–0.196	2.749	–3.429	0.412	–0.200
	(1.462)	(–0.146)	(1.229)	(–1.211)	(0.493)	(–0.143)
INTANG	9.661	0.400	10.486*	–18.542**	–1.917**	–2.304
	(1.284)	(0.138)	(1.839)	(–2.329)	(–2.182)	(–0.959)
INVENTORY	13.113	13.020	12.137	–22.327	2.156	–5.825
	(1.231)	(1.187)	(1.570)	(–1.601)	(1.371)	(–1.546)
ROA^{Adj}	–3.614*	–0.272	–0.195	–0.052	–1.940	–0.296
	(–1.822)	(–0.806)	(–0.194)	(–0.077)	(–1.101)	(–0.800)
CAPEX	–4.434	4.325*	0.139	6.221	–2.996**	3.038
	(–0.999)	(1.838)	(0.039)	(1.588)	(–2.522)	(1.008)
Constant	22.723***	25.547***	21.583***	29.397**	12.610***	32.310***
	(2.676)	(5.196)	(3.312)	(2.084)	(4.092)	(5.252)
N	1,546	5,888	1,884	1,739	873	1,213
Adjusted R-squared	0.223	0.113	0.241	0.282	0.079	0.162
Year fixed effect	YES	YES	YES	YES	YES	YES
Sub-industry fixed effect	YES	YES	YES	YES	YES	YES

Notes: This table reports the moderating effects of multinational operations, agency costs, and financial distress, respectively. The t-statistics are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels (two-tailed), respectively. Variable definitions are provided in Appendix 4.1.

4.6.2. The Role of Sub-Industry in Shaping R&D Payoffs

I further investigate whether the relationship between R&D investment and JMFs' valuation differs across sub-industries by categorizing firms into two groups: (1) Precious Metals and High-Value Metals; (2) Industrial Metals and Broad Mining Operations, based on their primary activities using GICS code. Group 1 includes industries focused on high-value metals such as gold, silver, and other precious minerals that are often driven by investment demand rather than industrial utility. In contrast, Group 2 consists of firms in industries like aluminum, steel, and copper that are closely tied to construction, manufacturing, and other industrial applications.

To evaluate this, I re-estimate my primary model separately for each group. Table 4.9 presents the results. For Precious Metals and High-Value Metals (Group 1), the coefficient on *R&D Intensity* is positive and significant (β_1 = 3.531, $p < 0.05$), indicating that R&D investments are valued positively in these sub-industries. For Industrial Metals and Broad Mining Operations (Group 2), the coefficient on R&D intensity is not statistically significant (β_1 = 3.930, $p > 0.10$). These findings suggest that the effect of R&D investment appears stronger and statistically significant in industries characterized by high-value and precious metals.

Table 4.9. The Role of Sub-Industry in Shaping R&D Payoffs.

	Dependent variable: *Tobin's* Q_{it+3}	
	Entropy Balanced Sample	
Variable	(1) Precious Metals and High-Value Metals	(2) Industrial Metals and Broad Mining Operations
R&D Intensity	**3.531****	**3.930**
	(2.337)	**(1.628)**
SIZE	–1.826***	–1.169***
	(–3.382)	(–3.740)
LEV	–14.704*	–2.798
	(–1.780)	(–1.144)

PPE	0.782	–0.011
	(0.525)	(–0.006)
INTANG	–0.994	2.459
	(–0.493)	(0.661)
INVENTORY	28.842*	9.222
	(1.784)	(0.940)
ROA^{Adj}	–2.740*	–0.524
	(–1.774)	(–1.450)
CAPEX	–3.878	3.182
	(–0.987)	(1.079)
Constant	32.265***	25.816***
	(4.042)	(4.062)
N	2,238	5,196
Adjusted R-squared	0.285	0.116
Year fixed effect	YES	YES
Sub-industry fixed effect	YES	YES

Notes: This table examines the sub-industry heterogeneity. Specifically, I split the sample into "Precious Metals and High-Value Metals" group and "Industrial Metals and Broad Mining Operations" group. The t-statistics are reported in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels (two-tailed), respectively. Variable definitions are provided in Appendix 4.1.

4.7. Conclusion

This study examines whether R&D investment is reflected in market valuation for Australian JMFs, a setting in which firms are small, often have limited operating cash flows, and R&D spending is infrequent. Using ASX-listed JMFs from 2000 to 2019 and applying entropy balancing to address covariate imbalance, I find that higher R&D intensity is positively associated with firm value measured by Tobin's Q. The association is economically meaningful. In the entropy-balanced sample, a one-standard-deviation increase in R&D intensity is associated with about a 0.38 increase in Tobin's Q three years later, which corresponds to roughly AUD 3.35 million higher market value of equity for the average firm in my sample, holding book values constant. The timing tests further suggest that the valuation association is concentrated over a medium horizon, with significant effects appearing in the two- to four-year lags rather than immediately, consistent with delayed market recognition of R&D-related benefits in a resource-constrained setting.

The additional analyses help interpret when and how R&D is more likely to be priced by the market in the junior mining segment. I find that the positive R&D–valuation association is stronger for firms with multinational operations and for firms with lower agency costs, and it is weaker when firms face tighter financial constraints. These patterns are consistent with the idea that financing capacity and governance affect whether R&D can be sustained and translated into value-relevant information for investors. I also document meaningful heterogeneity across mining sub-sectors: the positive association is concentrated in precious and high-value metals, while it is not present for industrial metals and broad mining operations.

Several features of my research design support the reliability of the findings. In addition to entropy balancing, I conduct a falsification test, a DID analysis around the 2012 Australian R&D Tax Incentive, PSM, alternative valuation measures, and sample exclusions, and the results remain consistent with my main conclusions. At the same time, my evidence should be interpreted as associational rather than fully causal. R&D choices are not random, and archival measures of R&D and uncertainty may not capture all project-level innovation activities in mining. The sample is also specific to listed Australian junior mining firms and may not generalize to other institutional settings.

Overall, the results suggest that, even in a setting where formal R&D spending is uncommon, markets appear to price R&D when it occurs, and the valuation implications depend on firm capacity, governance, and the mining sub-sector. For managers, the findings imply that R&D decisions and the credibility of related information may matter more when firms have the resources and governance to support follow-through. For policymakers, the evidence is consistent with the view that reducing the effective cost of R&D can be associated with higher market valuation in the junior segment, although the design and implementation details of support programs remain important. Future research could further refine these conclusions by incorporating more granular measures of project stage and technical progress, and by studying how disclosure practices around innovation and project development affect investor beliefs in early-stage resource firms.

Appendix 4.1. Variable Definitions and Data Sources.

Variable	Definition	Data Source
Dependent Variables		
Tobin's Q	Total assets minus book value of equity, plus market value of equity, divided by book value of total assets.	CompustatGlobal
MB	Market value of equity divided by book value of equity.	CompustatGlobal
Variables of Interest		
R&D Intensity	Two-year average of the ratio of research and development expenses to sales.	CompustatGlobal
R&D Expenditure	Natural logarithm of R&D expenditure.	
Post	An indicator variable equals to one starting the year in which the R&D Tax Incentive Policy becomes effective in Australia, and zero otherwise.	Own construction
Treat	An indicator variable equals to one for junior mining firms engaged in R&D projects with annual revenue below AUD 20 million, making them eligible for the refundable R&D tax offset, and zero otherwise.	Own construction
Other Variables		
R&D_Dummy	A dummy variable that equals one if JMFs incurred positive R&D expenditure, and zero otherwise.	CompustatGlobal
SIZE	Natural logarithm of total assets.	CompustatGlobal
LEV	Total debt divided by total assets.	CompustatGlobal
PPE	Property, plant, and equipment divided by prior year total assets.	CompustatGlobal
INVENTORY	Inventory scaled by prior year total assets.	CompustatGlobal
ROA^{Adj}	Net income before extraordinary items divided by book value of total assets. Following prior studies (e.g., Curtis et al.2020), I adjust income by adding back R&D, advertising, and depreciation expense.	CompustatGlobal

CAPEX	Capital expenditure divided by total assets.	CompustatGlobal
INTANG	Intangible assets divided by total assets.	CompustatGlobal
MULT	An indicator variable for non-zero international operating income, to capture multinational operations.	CompustatGlobal
Agency Cost	Selling, general and administrative expenses scaled by sales.	CompustatGlobal
Distress	Z-score, be defined by Altman (1968) to value the financial distress. $Distress = 1.2 \times \frac{Working\ Capital}{Total\ Assets} + 1.4 \times \frac{Retained\ Earnings}{Total\ Assets} + 3.3 \times \frac{Earnings\ before\ Interest\ and\ Taxes}{Total\ Assets} + 0.6 \times \frac{Market\ Value\ of\ Equity}{Total\ Liabilities} + 0.999 \times \frac{Sales}{Total\ Assets}$	CompustatGlobal

Appendix 4.2. Interviewee Details.

Interviewee	Position	Range of Firm Size
Int1	Managing Director & CEO	JMF
Int2	Chief Operating Officer & Exploration Manager	JMF
Int3	Managing Director	JMF
Int4	Exploration Manager	JMF
Int5	Processing Manager	JMF

Notes: This table reports the details of interviewee.

Appendix 4.3. Sample Selection.

Selection Criterion	Firm-Years
ASX junior mining firms (Metals & Mining, GICS 151040) on Compustat, 2000–2022, legally incorporated in Australia with market capitalisation ≤ AUD 500 million	10,766
Less: missing values in key control variables	-(355)
Less: missing *Tobin's Q* at *t+3* (includes fiscal years 2020–2022 excluded due to insufficient forward window)	-(2,977)
Final sample (fiscal years 2000–2019)	**7,434**

Notes: This table reports the sample construction process.

Chapter 5. General Discussion and Conclusion

Corporate responses to the climate transition are not reducible to a single choice. Firms make interrelated decisions about whether to commit to ambitious transition plans and how credibly to disclose their progress, how to manage the near-term financial costs of emissions reduction, and where to direct longer-horizon innovation investment. This thesis examines each of these dimensions and draws on their combined evidence to develop a more integrated account of how and why firms' transition responses vary.

Chapter 2 (Study 1) links transition plan status to both directional and continuous measures of GHG emissions performance using CDP climate disclosures from 2022 to 2024 across 57 countries and 11 GICS industry sectors. The evidence indicates that transition plan status is systematically related to emissions outcomes. First, using a directional measure of whether firms report an increase in total emissions (Scope 1 and Scope 2), firms with a 1.5°C-aligned plan are less likely to report increased total emissions, whereas firms with no plan and firms with a plan in development are more likely to report increased total emissions. Second, using continuous measures of year-over-year emissions change, firms without a transition plan show higher growth in total emissions, firms with a 1.5°C-aligned plan show lower growth in total emissions, and firms with a plan in development show no significant relation with total emissions growth. When decomposing total emissions, a 1.5°C-aligned plan is negatively associated with growth in direct emissions, while neither no plan nor a plan in development is significantly associated with Scope 1 growth. For indirect emissions, firms without a transition plan show higher Scope 2 growth, firms with a plan in development show lower Scope 2 growth, and a 1.5°C-aligned plan is not significantly associated with further slowing of Scope 2 growth.

The study also shows heterogeneity consistent with the role of context and disclosure credibility: the relations are stronger in carbon-intensive industries and in countries with lower cultural concern for environmental stewardship, and third-party assurance strengthens the association between planning status and reported emissions outcomes. Taken together, Study 1 suggests that "having a plan" is most informative when the plan signal is strong (for example, 1.5°C-aligned) and when reported outcomes are more verifiable (for example, with assurance), which is consistent with disclosure and credibility arguments in accounting and related fields (for example, Du and Wu 2019; Maroun 2020).

Chapter 3 (Study 2) examines whether emissions-reduction responses after the Paris Agreement are associated with higher corporate tax planning, and whether this association is stronger when firms face greater constraints in passing transition-related costs to customers or raising external finance. Using an international (non-United States) sample over 2011 to 2021, the study uses a difference-in-differences (DID) design that treats 2016 as the implementation year and compares firms that reduce emissions after 2016 to other firms. The main evidence suggests that emissions-reducing firms engage in higher tax planning after the Paris Agreement relative to other firms, with economically meaningful magnitudes across common tax-planning proxies. Cross-sectional evidence is consistent with a cash-flow pressure interpretation tied to cost pass-through limits and financing frictions: the effect is stronger when firms face tighter constraints on passing costs to customers and when firms are more financially constrained, and it is also stronger in countries with stronger institutions. These findings suggest that firms use tax planning as one tool to preserve internal liquidity when mitigation imposes near-term cash demands and when external or operational channels of adjustment are more limited (Edwards et al. 2016; Linnenluecke et al. 2016).

Chapter 4 (Study 3) uses ASX-listed Australian junior mining firms (JMFs) from 2000 to 2019 to examine whether capital markets price R&D investment in a carbon-intensive setting where R&D is infrequent but potentially informative. Mining faces both technical constraints, including declining ore grades and deeper deposits, and growing environmental and social expectations that increase attention to new exploration and processing methods. The study finds that higher R&D intensity is positively associated with firm value (Tobin's Q), with the strongest effects over a two- to four-year horizon. In the entropy-balanced sample, a one-standard-deviation increase in R&D intensity is associated with approximately a 0.38 increase in Tobin's Q three years later, corresponding to roughly AUD 3.35 million in higher market value of equity at the sample mean. The valuation association is stronger for JMFs with multinational operations, lower agency costs, lower financial distress, and for firms in the precious metals sector. These findings extend the literature on the valuation of intangible investment (e.g., Lev and Sougiannis 1996; Aboody and Lev 2000; Leung and Sharma 2021) to a setting where project cycles are long and financing needs are acute.

Taken together, the thesis supports a view of corporate climate transition responses as an interconnected set of information and resource allocation choices rather than isolated actions. Three cross-cutting insights emerge from the combined evidence. First, the credibility of transition commitments is not uniform. Transition plan status contains information about emissions trajectories, but the signal is most useful when ambition is high (e.g., 1.5°C-aligned) and when reported outcomes are externally verified (e.g., through third-party assurance). The heterogeneity by cultural context further suggests that formal planning carries the most incremental information in settings where informal social norms are weakest, an implication that bears on how transition-disclosure requirements should be designed and enforced across jurisdictions.

Second, transition-related costs generate financial behavioural responses that extend beyond environmental balance sheets. When emissions reduction raises costs that cannot easily be passed through to customers or financed externally, firms adjust their tax planning behaviour in ways consistent with preserving internal liquidity. This finding connects climate policy to corporate tax behaviour in a manner that has received limited prior attention: climate measures such as carbon pricing affect not only operational choices but also firms' tax positions, and the two are linked by a common cash-management logic (Hart 1995; Hart and Dowell 2011; Fabra and Reguant 2014; Jacob and Zerwer 2024). This connection has practical implications: regulators and standard setters who focus exclusively on emissions metrics may miss the broader financial behavioural responses that climate policy induces, including a potentially increased reliance on tax planning as a liquidity tool.

Third, the timing and conditionality of market recognition of R&D investment shows how financing frictions interact with longer-horizon transition progress. The delay in R&D pricing in Australian JMFs is not simply a mechanical consequence of accounting treatment; it reflects the real difficulties investors face in valuing inherently uncertain, long-cycle innovation projects in resource-constrained firms (Lev and Sougiannis 1996; Aboody and Lev 2000; Curtis et al. 2020). The finding that valuation effects are stronger for firms with lower agency costs, better governance, and lower financial distress suggests that market recognition of innovation investment is partly gated by the credibility of governance and the reliability of financial signals (e.g., Le et al. 2006; Chan et al. 2015; Cui and Mak 2002; Filippou and King 2011; Balci and Kumral 2022).

This thesis makes several contributions. First, the existing literature documents a wide range of firm responses to climate change, including adaptation, carbon target setting, disclosure quality, and symbolic versus substantive climate strategies (e.g., Bui and De Villiers 2017; Dahlmann et al. 2019; Liao et al. 2018; Coen et al. 2022; Moussa et al. 2022). I add to this strand of research by providing large-sample international evidence on climate transition plans as a formalised strategic response, showing how firms' transition plan status, including whether a plan is 1.5°C-aligned, relates to subsequent changes in emissions. I further show that this relation varies systematically with contextual and governance conditions, including country-level cultural concern for environmental stewardship, industry carbon intensity, and third-party assurance that strengthens disclosure credibility.

Second, prior studies emphasise that the Paris Agreement has important macro and environmental implications, while firm-level evidence has focused mainly on external financing and valuation outcomes (Salman et al. 2022; Degryse et al. 2023; Pang et al. 2023). Building on the view that firms invest in environmental capabilities under climate-policy pressure (Hart 1995; Hart and Dowell 2011) and that their ability to pass transition-related costs through to stakeholders depends on market structure and pricing power (Fabra and Reguant 2014; Jacob and Zerwer 2024), I show that corporate tax planning is a previously under-examined adjustment channel through which emissions-reducing firms respond to post–Paris Agreement cost pressures. The evidence indicates that emissions-reducing firms increase tax planning after the Agreement and that the association is stronger when cost pass-through and financing capacity are more limited, consistent with firms using tax planning to preserve internal liquidity when transition costs are harder to absorb through product-market adjustments or external finance (Edwards et al. 2016; Linnenluecke et al. 2016).

Third, research on R&D and firm valuation shows that innovation investment can be value relevant, but that market pricing may be delayed when information asymmetry and uncertainty are high (Lev and Sougiannis 1996; Aboody and Lev 2000; Curtis et al. 2020). I extend this literature by providing evidence from Australian junior mining firms, a carbon-intensive setting facing growing environmental and social expectations that increase attention on new exploration and processing methods, and in which firms are resource constrained and R&D spending is uncommon but salient when it occurs (Kreuzer et al. 2007; Iddon et al. 2015;

Adler et al. 2017). I show that R&D intensity is positively associated with firm value with the strongest effects emerging over a medium horizon, and that the valuation association varies systematically with firm characteristics linked to financing capacity and governance frictions, consistent with financing constraints and monitoring shaping how investors interpret innovation signals (e.g., Le et al. 2006; Chan et al. 2015; Cui and Mak 2002; Filippou and King 2011; Balci and Kumral 2022).

The findings have implications for managers, investors, and regulators. For managers, the evidence indicates that transition planning is most likely to align with improved emissions trajectories when plans are both ambitious and credibly disclosed, and that near-term implementation costs, particularly when difficult to pass through, may amplify reliance on tax planning as a cash-management tool. For investors, the results indicate that transition-relevant information is uneven in credibility and timing: assurance strengthens the link between planning status and reported outcomes, and R&D investment in carbon-intensive settings may be value relevant but priced with a delay that depends on governance quality and financial capacity. For regulators and standard setters, the evidence supports strengthening the verifiability and comparability of transition disclosures (FSB 2025; IFRS 2024), and points to climate–tax interactions that warrant coordinated policy attention: carbon-pricing mechanisms may inadvertently encourage greater tax planning among firms with limited cost pass-through capacity, suggesting benefits from aligning climate and tax policy design.

As in any empirical work, the thesis has limitations that suggest directions for future research. In Study 1, emissions measures are based on firms' disclosed data. Although the analysis explicitly examines third-party assurance as a mechanism that improves disclosure credibility, measurement error and non-random disclosure remain potential concerns, particularly for firms with limited or discontinuous emissions histories. Future work could use settings with exogenous changes in disclosure requirements, richer plan content measures, and longer horizons to better distinguish substantive implementation from disclosure strategy.

In Study 2, the identification design relies on an implementation-year partition around the Paris Agreement and an emissions-reduction classification to compare changes in tax planning across firms. As in other studies of large-scale policy shifts in cross-country settings, a key concern is that concurrent macroeconomic or institutional changes could affect the estimates. To address this concern, I control for emissions trading schemes and carbon tax policies and conduct robustness checks, including alternative samples, trend analyses, and placebo tests. While these approaches reduce the likelihood of confounding influences, they may not fully rule them out. Future research could use more discrete regulatory shocks to provide sharper variation.

In Study 3, the setting is intentionally narrow, and the results may not generalize to other sectors; future research could test whether similar delayed pricing patterns occur for R&D investment in other carbon-intensive industries and could link innovation signals more directly to operational transition outcomes.

Overall, this thesis shows that understanding corporate climate transition responses requires attention to how firms jointly manage (i) the credibility of transition commitments and disclosed outcomes, (ii) internal financing responses to transition-related cost pressures, and (iii) innovation investment and the timing with which markets recognize its value. By bringing these elements together, this thesis provides a more connected account of why some transition actions are more closely associated with observable outcomes than others, and why the consequences of transition efforts appear not only in emissions performance but also in financial behaviour such as tax planning and in capital market valuation. The evidence shows that firms, investors, and regulators stand to benefit from treating transition planning, financial adaptation, and innovation investment as interdependent rather than independent dimensions of the corporate climate transition.

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