Integrating Climate Into Corporate Finance: Global Evidence On Internal Carbon Pricing [*]

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Abstract – We study the determinants and effectiveness of internal carbon pricing (ICP) by publicly listed firms worldwide. Firms with a smaller board or committed to science-based targets set higher levels of ICP, while the US withdrawal from the Paris Agreement reduced the likelihood of ICP adoption by US firms. ICP adopters have lower future profitability and allocate less capital to more profitable divisions. Furthermore, ICP adoptions do not significantly influence risk-adjusted returns but are associated with lower growth of carbon emissions. Overall, our results suggest that ICP contributes to the low-carbon transition by integrating climate into corporate finance decisions.

Keywords: Carbon pricing; Corporate governance; Capital budgeting; Sustainable finance; Carbon emissions.

JEL classification: G12, G34, Q54, M14

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Abstract

We study the determinants and effectiveness of internal carbon pricing (ICP) by publicly listed firms worldwide. Firms with a smaller board or committed to science-based targets set higher levels of ICP, while the US withdrawal from the Paris Agreement reduced the likelihood of ICP adoption by US firms. ICP adopters have lower future profitability and allocate less capital to more profitable divisions. Furthermore, ICP adoptions do not significantly influence risk-adjusted returns but are associated with lower growth of carbon emissions. Overall, our results suggest that ICP contributes to the low-carbon transition by integrating climate into corporate finance decisions.

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"It Is Time To Put A Price On Carbon."

— António Guterres, UN Secretary-General, State of the Planet Address, December 2020

1. Introduction

In recent years, climate change has emerged as one of the most pressing global challenges, prompting policymakers and businesses to act. As countries strive to meet the goals set by the Paris Agreement, corporations are increasingly adopting voluntary mechanisms to align their operations with global environmental objectives. Among these strategies, internal carbon pricing (ICP) has gained prominence as a tool for companies to integrate climate action into corporate finance and governance processes (WBCSD, 2025). Almost half of the world's 500 largest companies had implemented or planned an ICP by 2021, which more than doubles the share in 2017, indicating the private sector's effort to price carbon internally in the absence of a unified global carbon pricing mechanism[2] (World Bank, 2021). Meanwhile, regulatory requirements are rising: the IFRS Sustainability Disclosure Standard, effective for reporting periods beginning on or after January 2024, requires entities to disclose whether and how ICP are used in decision-making (e.g., investment decisions, transfer pricing and scenario analysis) and the price applied per metric tonne of greenhouse gas (GHG) emissions (IFRS, 2023).

By internally setting a price on carbon, firms commit themselves to managing climate-related risks and opportunities in a more systematic way (CDP, 2014, 2019). A well-executed ICP would enable firms to integrate climate into traditional financial decision-making tools, such as the net present value and internal rate of return, influencing capital budgeting decisions for carbon-intensive projects, and drive capital expenditure towards energy efficiency and low-carbon technologies. Proponents of ICP believe that putting a price on emissions internalizes external costs, shift capital allocation toward low-carbon options, and signals sustainability commitment to stakeholders, thereby aligning business decisions with climate goals (CDP, 2021). From this perspective, ICP can be

[2] Global compliance carbon markets remain fragmented and cover only a limited set of industries and jurisdictions, leaving most emissions unpriced. In November 2025, the Open Coalition for Compliance Carbon Markets was launched at COP30 in an effort to advance coordination and expansion of mandatory carbon markets worldwide.

viewed as a forward-looking mechanism led by firms to price carbon voluntarily in their corporate financial decisions, and navigate the complexities of the transition to a low-carbon economy.

However, the decision-making process behind the setting of ICP and the scope of its application is often unclear, though. Due to the lack of transparency in how firms price carbon internally, ICP is also criticized as a "dark art" where firms are vulnerable to accusations of "greenwashing" or making symbolic gestures without substantial impact (Financial Times, 2023). Critics argue that without proper oversight or a clear regulatory framework, ICP could merely become a tool for corporate image-building rather than a genuine commitment to emission reduction, and shift capital away from profitable investment opportunities[3].

In this paper, we provide a comprehensive global analysis of the drivers and effectiveness of ICP. We start by documenting the adoption, price levels, and types of ICP used by publicly listed firms around the world, and we ask three core questions. First, which corporate governance structures, stakeholder relationships, carbon transition risks, and national climate policies shape firms' decisions to adopt ICP, set its level, and choose specific pricing types? Second, how does ICP affect corporate financial performance, including accounting profitability, capital allocation across business segments within the firm, and future stock returns? Third, we ask whether or not ICP is effective in reducing firms' future carbon emissions. To our knowledge, this study is the first to systematically examine the determinants and the effectiveness of ICP around the world, analyzing how internal governance and external policy factors shape firms' adoption decisions and price levels, and how they, in turn, influence corporate financial performance and future emission reductions.

To answer these open questions, we employ data on firms' disclosure on ICP from the Carbon

[3]We find that firms exhibit discretion over the adoption, level, and the scope of their ICP applications. Take automobile manufacturers from the 2021 CDP dataset as an example. The German automaker Volkswagen adopts a fixed ICP of approximately \$500/tCO2e, directly tied to EU fleet-emission penalties and applied narrowly to new passenger cars sold in Europe. By contrast, Ford mirrors the fluctuating EU Emission Trading Scheme (EU ETS) allowances price, about \$32/tCO2e, and operates an internal trading system in which allowances are centrally managed and exchanged among their EU facilities. The Japanese automotive manufacturer Nissan uses an ICP of approximately \$194/tCO2e, calculated based on carbon-reduction potential from investments. The Korean automaker Hyundai applies a forward-looking price across all global business units, assuming a linear rise from approximately \$30 to about \$100/tCO2e by 2050, informed by carbon market forecasts and regulatory expectations. These examples illustrate that, in practice, ICPs differ widely even within the same industry.

Disclosure Project (CDP) for reporting periods from 2014 to 2021. CDP collects detailed information on whether companies have adopted an ICP, the level of any internal price, and - more recently - the type of ICP in use. For the early period from 2014 to 2017, CDP does not provide standardized ICP-type labels. We therefore manually code firms' textual responses into dummy variables capturing five distinct ICP types: shadow price, implicit price, internal trading, internal fees, and offsets.[4] The process of hand-collecting data allows us to construct a consistent panel of ICP types and price levels across the full sample period. After merging with other financial datasets, our full sample covers 2,024 unique listed firms (8,604 firm-year observations) that respond to CDP, including 697 adopters of ICP (2,157 firm-year observations with reported price levels) across 54 developed and developing markets. Within the CDP sample of firms, who are firms voluntarily disclose information on carbon, 25% of them report that they have adopted an ICP strategy. We use the other 75% of firms as our control sample of non-adopters in our regression analysis[5]. We estimate models for (i) ICP adoption and (ii) ICP price levels with appropriate firm-level controls and fixed effects, and run type-specific specifications for shadow price, implicit price, internal fee, internal trading, and offsets. To our knowledge, this study represents the most comprehensive examination of ICP practices in the literature.

Guided by our first research question, we analyze four (non-mutually exclusive) channels that may jointly determine the adoption, pricing, and type-specifics of ICP: i.e., board governance, stakeholder governance, carbon transition risk, and national climate policy. In terms of board structure, prior research shows that characteristics such as majority voting rules and gender diversity influence firms' environmental strategies and disclosure practices (Dyck, Lins, Roth, Towner, and Wagner, 2023). We find that firms with smaller boards set significantly higher internal carbon prices: each one-member reduction in board size is associated with a 5% increase in the ICP level on

[4]Each category of ICP entails distinct approaches for implementation. Shadow prices function as forward-looking hypothetical carbon costs, often anchored to prevailing or forecasted regulatory prices. Implicit prices typically inform future investment decisions based on previous cost of emissions reductions. Internal fees impose a per-unit charge on business-unit emissions, whereas offsets reflect the cost of purchasing external carbon credits to compensate for residual emissions. See the next section for further details.

[5]Because firms self-select into the CDP sample through voluntary reporting, we use non-adopters within the CDP universe - rather than firms that do not report to CDP - as controls to mitigate selection concerns.

average. This pattern is particularly pronounced for shadow prices, consistent with the idea that smaller, more agile boards are better able to adopt ambitious, forward-looking climate strategies. We also document that stronger environmental performance are associated with greater adoption of ICP in the future, especially for shadow prices and internal fees. In addition, the sustainability committee score is positively associated with future ICP price levels, a 10-point score improvement increase the average ICP price by \$1.75/tCO2e. This suggests that firms with more structural oversight on sustainability set higher ICP levels.

Beyond internal governance factors, firms' exposure to carbon-transition risk is another important driver of ICP strategies. Carbon transition risk - the risk arising from regulatory, technological, and market shifts during the low-carbon transition - has material implications for investment decisions (Bolton and Kacperczyk, 2021; Krueger, Sautner, and Starks, 2020; Dyck, Lins, Roth, and Wagner, 2019). We find that adopting science-based targets (SBTs) to manage carbon-transition risk results in a higher probability of ICP adoption by 14.5%. It also raises average ICP price level by 18.5%. These findings imply that firms committed to SBTs are not only more inclined to adopt ICP but also tend to set higher pricing levels, suggesting that ICP as an internal tool is part of a boarder strategy for firms to manage the green transition. Interestingly, firms with higher direct emissions, which are also more exposedd to transition risk, are more likely to adopt ICP into environmental management in their attempt to manage climate risk.

Related to the transition risk channel, external policy environment further shapes ICP behaviour. National climate policy, including existing regulations and anticipated future policy stringency, influence corporate financial risk and strategic planning; firms exposed to climate-related policy uncertainty have incentives to proactively manage carbon exposure (Trinks, Mulder, and Scholtens, 2022; Ilhan, Sautner, and Vilkov, 2020). We find that changes in external policy changes matter: in particular, the United States' withdrawal from the Paris Agreement in 2017 is associated with a noticeable decline in ICP adoption among U.S. firms, reflecting a broader shift in corporate behavior in response to policy signals.

Our second set of results examines the financial consequences of adopting ICP. We first assess whether ICP adoption and pricing affect firm profitability, measured by return on assets (ROA) and operating profit margin (OPM).Firm profitability declines significantly following ICP adoption. More specifically, ROA falls by about 0.05% and OPM by approximately 0.4% in the following one to two years, both statistically and economically significant. By contrast, ICP price levels do not have an additional effect on profitability, indicating that it is the adoption decision - rather than the price magnitude - that drives the impact on firm profits. To explore the underlying mechanisms, we use within-firm data at the division level in the US to examine internal capital allocation. After adopting ICP, firms reallocate capital expenditure from divisions with high ROA towards those with lower profitability, with stronger effects in firms with smaller boards. The internal shift in capital allocation may have contributed to profitability decline as previously observed. Furthermore, we investigate the predictability of ICP on future stock returns and examine whether market reactions exhibit similar cross-sectional variation across industries and countries. We do not find that ICP has a significant impact on future risk-adjusted returns for investors, suggesting the effect of ICP on profits is priced in by the stock market.

Finally, we study the impact of ICP on subsequent carbon emissions trajectories to evaluate its effectiveness in facilitating decarbonization. We study both total emissions and emission intensity to capture scale and efficiency effects. We find that ICP adoption reduces the rate of emission growth over the next two years. Higher ICP price levels predict lower emission intensity in the next year, which suggests that emissions growth among high-ICP firms is outpaced by revenue growth. These patterns suggest that internal carbon pricing help flatten the emissions-growth curve. Nevertheless, the overall effect of ICP on emission reduction is limited as we do not observe an overall reduction in emissions - in fact, firms setting higher ICP levels still produce significantly higher total emissions next year suggesting their carbon footprints have not peaked yet. This implies that internal carbon pricing alone yields limited decarbonization benefits in the short-term, as the benefits of integrating climate into corporate finance and governance process may only be realized over the longer term.

Overall, the evidence suggests that internal carbon pricing is not a 'dark art' exercised by firms merely to enhance corporate image. It correlates with several aspects of corporate governance and climate policy that one would expect to influence firms' sustainability decisions. ICP is not a 'free lunch' for firms, though: it reduces firm profitability in the short term. Consistent with this, we find that ICP shifts capital allocation away from more profitable business divisions of a firm, possiblly investing in the low-carbon transition, which suggests a capital budgeting effect when climate is integrated into corporate finance processes. We do not find that ICP significantly affects risk-adjusted returns as the effect on profitability is priced in by the stock market. Further, ICP adoption leads to a reduction in emission growth, yet its overall impact on emission reduction remains limited. These findings imply that achieving meaningful decarbonization is likely to require complementary measures such as stricter regulatory standards, technological innovation, and broader integration of sustainability into corporate strategy - alongside voluntary internal carbon pricing initiatives.

Our contributions are threefold. First, we construct and analyze the most comprehensive global panel of ICP disclosures to date, covering 2014-2021. We compile the latest CDP dataset and manually code firms' textual responses for 2014-2017 to recover ICP types when type labels are missing. By integrating these manual classifications, we expand type-level adoption and price coverage and are able to jointly analyze ICP adoption, price levels, and type choices, extending prior studies that typically focus on a single dimension (Trinks, Mulder, and Scholtens, 2022; Bento and Gianfrate, 2020; Bento, Gianfrate, and Aldy, 2021; Ben-Amar, Gomes, Khursheed, and Marsat, 2022).

Second, we investigate how internal governance, stakeholder engagement, and carbon transition risks shape corporate decisions on ICP adoption and pricing. Our framework sheds light on the multifaceted decision-making processes underlying firms' carbon management strategies, advancing prior literature on the influence of governance on environmental performance (e.g., Damert, Paul, and Baumgartner 2017; Dyck, Lins, Roth, Towner, and Wagner 2023) and the financial implications of carbon transition risks (Bolton and Kacperczyk, 2021, 2023). We further assess ICP's role in promoting long-term decarbonization by analyzing its integration with science-based targets (SBTs) and actual emission reductions. Our work is related to recent research on SBTs (Li, Peng, and Zhang, 2024; Bjørn, Lloyd, and Matthews, 2021; Freiberg, Grewal, and Serafeim, 2021; Kuo and Chang, 2021). By investigating national climate policy changes, our analysis also further captures how regulatory expectations and policy uncertainty interact with internal firm structures in determining ICP implementation.

Finally, we assess both the financial and environmental effectiveness of ICP. We examine how ICP adoption and price levels relate to profitability (ROA and OPM) and stock market performance, and we show that ICP implementation entails short-term financial costs without generating abnormal returns. In contrast to Ma and Kuo (2021), who document a positive association between ICP and profitability in a narrower setting, our global evidence points to net costs in the short run. While prior studies have shown that regulatory carbon pricing and climate risk disclosures are priced by financial markets (Bolton and Kacperczyk, 2021; Ilhan, Sautner, and Vilkov, 2020; Hsu, Li, and Tsou, 2023), we are the first to test whether voluntary ICP affects both firm performance and stock returns at scale. Our findings complement this evidence by linking ICP implementation to both financial outcomes and realized emission reductions, providing new insight into whether and how voluntary carbon pricing contributes to the low-carbon transition.

The remainder of the study is organized as follows. Section 2 reviews the institutional background and related literature of ICP. Section 3 describes the data source and descriptive statistics of our sample. Section 4 analyzes the drivers of ICP adoption, price levels, and type choices. Section 5 examines the financial effects of ICP on profitability, capital allocation, and stock performance. Section 6 investigates the impact of ICP on firms' carbon emissions, and Section 7 concludes and discusses policy implications.

2. Institutional Background and Related Literature

2.1 Global trend of ICP and related literature

The adoption of ICP has expanded steadily over the past decade. Early corporate experiments, such as BP's internal emissions trading system in 1998 (Akhurst, Morgheim, and Lewis, 2003), demonstrated the potential for internal price signals to support emissions reductions, despite challenges in setting quantities and stabilizing prices (Victor and House, 2006). A broader wave of adoption occurred after 2014 as firms sought to prepare for tightening climate policy, investor scrutiny, and emerging disclosure expectations (CDP, 2014). By 2021, more than 2,000 firms-including nearly half of the world's largest companies-reported using or planning to implement an ICP within two years (CDP, 2021, 2022). Figure 1 shows that ICP adoption in our sample increased markedly between 2014 and 2021.

[Insert Figure 1 Here]

Existing studies suggest that firms adopt ICP to support internal decision-making, signal environmental commitment, or anticipate explicit carbon pricing policies, thus enhancing their standing and attractiveness to clients, investors, and other stakeholders who are progressively mindful of environmental issues (Victor and House, 2006; CDP, 2022; Trinks, Mulder, and Scholtens, 2022; Bento, Gianfrate, and Aldy, 2021; Bento and Gianfrate, 2020). ICPs send internal price signals that encourage energy efficiency and low-carbon investment, and can serve as preparatory tools for external carbon markets. Table 1 summarises the growing, yet still limited, body of ICP related research.

[Insert Table 1 Here]

The empirical evidence links ICP adoption to several firm characteristics and policy environments. Firms are more likely to adopt ICP when operating under stringent climate regulations or explicit carbon pricing regimes (Trinks, Mulder, and Scholtens, 2022), in carbon-intensive sectors (Ma and Kuo, 2021), or when facing greater transition-risk exposure and stronger corporate governance (Ben-Amar, Gomes, Khursheed, and Marsat, 2022). In order to mitigate future transition risks, voluntary ICPs are often set at levels higher than the explicit carbon price observed in ETS and carbon taxes (Bento, Gianfrate, and Aldy, 2021). In addition, good corporate governance plays a role in facilitating ICP adoption, with research indicating that independent boards and effective governance increase adoption when corporations face climate change exposure (Ben-Amar, Gomes, Khursheed, and Marsat, 2022).

Studies also examine how the adoption of ICP affects firms' financial performance. Ma and Kuo (2021) provides empirical evidence on the effectiveness of ICP in enhancing financial performance. The analysis of a panel dataset of 132 multinational enterprises across Europe, North America, and Asia reveals that the use of ICP leads to a 1.1% increase in ROA. Kuo and Chang (2021) explores the relationship between ICP and corporate reputation. Their analysis of data from 1,994 Japanese firms from 2016 to 2019 shows that the adoption of ICP, especially when conducted with science-based targets, significantly boosts carbon management reputation in high-emission industries. Using the US data, Zhu, Xu, Wang, and Zhang (2022) provides evidence that ICP is effective in terms of environmental performance. According to their study, ICP reduced the corporate carbon emissions, and improve corporate environmental performance. The adoption of ICP reduced carbon emissions per employee and per revenuw by 13.5% and 15.7%, respectively. Byrd, Cooperman, and Hickman (2020) conducts a study using data from 45 countries and discovered that ICP only leads to an acceleration of carbon intensity in capital-intensive industry sectors with high CO_2 emissions.

2.2 Five types of ICP

The CDP has classified ICPs into six distinct categories: shadow price, implicit price, internal fee, internal trading, offset, and others. Each of these categories represents a unique mechanism for integrating carbon costs into corporate operations. Table 2 presents detailed definition, mechanism, advantage and disadvantage, and case study for five types of ICP. This categorization is essential for understanding the diverse mechanisms that these different ICPs can have on a firm's carbon management strategies and overall financial performance.

[Insert Table 2 Here]

These design differences have important implications for how ICP affects investment behaviour and corporate outcomes. The adoption of ICPs, especially their pricing, varies according to their types. For example, the implicit price reflects technological investment in low carbon technologies, its price level is generally higher than offset credits or the internal fee charged by firms. A carbon intensive firm may be able to reduce its emissions by purchasing offsets, but it will not be able to mitigate the firm's climate regulatory risk effectively. Prior studies have rarely examined type heterogeneity due to data limitations (Bento and Gianfrate, 2020; Torres, Andrade, Gomes, and Ribeiro, 2019). CDP only introduced type-specific ICP disclosure questions in 2018. To ensure consistent classification across the full sample period, we manually coded firms' textual responses from 2014 to 2017 to identify ICP types. This enables a comprehensive analysis of ICP design, adoption, and pricing from 2014 to 2021.

3. Data

Our sample consists of firms that disclose their ICP strategies to the Carbon Disclosure Project (CDP) between 2014 and 2021 and matched to financial and governance data from Refinitiv, Bureau van Dijk Orbis, and Kenneth French's factor datasets[6]. This integrated dataset enables a comprehensive examination of ICP adoption, pricing, and firm-level characteristics across global companies. The initial dataset includes 4,350 firms from 59 developed and developing markets and 18,380 firm-year observations. Due to missing financial and governance information - particularly firm size, leverage, profitability, cash, asset tangibility, board size, board independence, female representation, and market-to-book. Our final merged panel comprises 2,024 firms (8,604 firm-year observations), including 697 ICP adopters that report 2,157 annual price observations across 54 jurisdictions. Table 3 reports summary statistics for all variables[7].

[Insert Table 3 Here]

[6]The CDP data serve as the primary sample framework, which we matched with firm-level financial and governance variables from Refinitiv, Bureau van Dijk Orbis, and Kenneth's Library.

[7]Table A1 in Appendix provides the detail definitions of all variables.

3.1 Data on Internal Carbon Price

Our main variables of interest capture whether and how firms price carbon internally. We focus on four measures: (i) the *ICP Adopter* - i.e, a dummy variable equals one if a firm adopts ICP in a given year, and zero otherwise, (ii) *ICP Level* - defined as the natural logarithm of the firm's average ICP price (in $ per ton CO2e) in that year[8]; (iii) *ICP Adopter by type* - a dummy variable equals to one when a firm adoptes a specific ICP type (shadow price, implicit price, internal fee, internal trading, or offsets) in a given year, and zero otherwise; and (iv) *ICP Level by type* - natural logarithm of the price associated with the specific ICP type adopted in that year. To mitigate the impact of extreme price outliers, ICP data are winsorized at the 1st and 99th percentiles to reduce the influence of outliers.

Panel A in Table 3 provide insights into the distribution of ICP across the sample. The *ICP Adopter* variable has an average of 0.25 indicating that about one-quarter of firm-year observations involve ICP usage. The mean ICP price is $49.34/tCO2e, with a standard deviation of 81.83, and a median of $28.56, highlighting a right-skewed distribution in which many firms set modest internal prices while a smaller group adopts very high levels. The log-transformed ICP variable, *ICP Level* has a mean of 3.3 and a standard deviation of 1.13.

3.2 Board and Stakeholder Governance Measures

All governance measures are constructed at the firm-year level and are used to examine how internal governance shapes firms' decisions to adopt and price ICP. We measure board governance using four firm-year indicators: *Board Size* the total number of directors, *Board Independence* measures the percentage of independent directors on the board, *Female* - the share of female board members, and the *Majority Election Score* which reflects the extent to which firms employ majority voting in director elections. Board in our sample has an average size of about 11 members, of whom approximately 61% are independent and 20% are female directors. The majority election score, has

[8]For firms reporting various types of ICPs and corresponding prices within a specific year, an annual firm-level average ICP is computed to enable cross-sectional analysis of price level determinants.

an average of 48.9.

To characterize stakeholder governance, we draw on Refinitiv's ESG Indicators: *Environmental Rating* evaluates firms' past environmental performance and risk management, essentially the "E" component of ESG ratings; *Sustainability Committee Score* indicates the presence and depth of a dedicated sustainability or CSR committee; *Sustainability Report Score* captures the transparency and comprehensiveness of ESG disclosures; and *Stakeholder Engagement Score* measures the breadth and effectiveness of firms' interactions with their stakeholders. *Environmental Rating* average 61.7, indicating that firms in our sample demonstrate generally solid environmental performance.

3.3 Financial and Carbon Transition Risks

All firm-level financial variables used in our analysis are obtained from Refinitiv, including Return-on-Asset (*ROA*), Operating Profit Margin (*OPM*), stock returns, and a set of control variables such as firm size (*Size*), book-to-market ratio (*BM Ratio*), cash holdings (*Cash*), leverage (*Leverage*), etc. We obtain factor return data from Kenneth French's Global Factor Datasets. Specifically, we use the market factor (*MKT*), size (*SMB*), value (*HML*), and momentum (*MOM*) factors. We utilize region-specific factor portfolios for Asia Pacific (excluding Japan), Europe, North America, Japan, the United States, developed markets excluding the US, and emerging markets. Each firm is matched with the corresponding factor dataset based on its home country. If no country-level match is available, firms are classified according to whether their home market is developed or emerging. In the analyses of ICP and firm performance, we employ quarterly and monthly data depending on model specification. Specifically, the profitability regressions use 38,927 firm-quarter observations, whereas the stock return regressions are based on 101,395 firm-month observations. As the control variable sets differ across models, the number of observations varies slightly between specifications. Firm-level controls are winsorized at 1% on both sides.

At the macro level, we incorporate the following country-level economic indicators from the World Bank: GDP growth (*GDP growth*), GDP per capita (*GDP per capita*), the ratio of GDP to total market capitalization (*GDP mktcap*), and the inflation rate (*Inflation*). For our U.S. division-level subsample analysis, we use Compustat Segment Data, which provide information on divisional capital expenditure intensity (*Capital Expenditure (Division)*), return on assets (*ROA (Division)*), size (*Size (Division)*), and age (*Division Age*). Regarding carbon transition risk, we include Science-Based Targets (SBT) and Scope 1 and Scope 2 carbon emission data as firm-level proxies for transition exposure. These data are

In addition to financial and macroeconomic controls, we incorporate measures of carbon transition risk primarily obtained from CDP, supplemented with Refinitiv data to fill missing observations: the adoption of science-based target, *SBT*, a dummy variable equals to one if a firm adpots the science-based target and 0 otherwise; *Scope1 Emission* and *Scope2 Emission*, representing the logarithmic carbon emissions of a firm's emission under Scope 1 and Scope 2 (in tons CO_2e), respectively. Δ *Scope1* measures the annual growth rate of emissions under Scope 1. *Scope 1 Emission Intensity* represents the *Scope1 Emission* divided by the total revenue of the firm. Carbon-transition risk variables are primarily obtained from CDP, supplemented with Refinitiv data to fill missing observations, and are winsorized at 2% on both sides.

3.4 ICP Across Countries, Industries, and Types

Understanding the motivations behind the adoption of ICP provides crucial insight into how different industries approach this strategy. While the underlying principles of ICP are generally uniform, their application and impact vary significantly across industries, sector, and jurisdictions due to their unique operational characteristics and environmental footprints. Figure 2 highlights the global footprint of ICP engagement across countries and continents. Although firms reporting to CDP span more than fifty jurisdictions, ICP engagement is concentrated: both the full sample (Panel A) and the adopter subsample (Panel B) show the same top five countries - Japan, the United States, the Republic of Korea, the United Kingdom, and Canada. While the number of U.S. firms ranks top one in the CDP dataset overall, Japan becomes the largest ICP adopter once we restrict attention to firms that actually implement an ICP. This pattern reflects differences in disclosure cultures, investor pressure, and regulatory expectations across jurisdictions. Outside these markets, adoption remains limited but steadily expanding, suggesting that internal pricing is diffusing beyond early movers. Figure 3 further reports the number of unique companies engaged with ICP across ICB industries and sectors, showing that technology, financials, industrials, energy, and basic materials have the largest concentration of firms engaging in ICP reporting.

[Insert Figure 2 Here]

[Insert Figure 3 Here]

Turning to price levels among ICP adopters, Figure 4 shows heterigeneity across industries. Mean ICP level cluster around $32-42/tCO2e in energy, basic materials, technology, and utilities - sectors that are typically emissions intensive and already exposed to explicit regulatory carbon pricing. By contrast, health care exhibits the highest average price ($117.95/tCO2e), followed by consumer discretionary and industrials, where average prices reach $55-75/tCO2e. These higher ICP levels in relatively less carbon-intensive sectors suggest that ICP may operate partly as a strategic or forward-looking tool, reflecting reputational concerns, investor expectations, or longer-horizon decarbonization commitments. consumer discretionary and industrials staples fall in the mid-range, indicating moderate carbon-valuation practices. Overall, the distribution of ICP levels across adopters does not align neatly with emissions intensity, reinforcing the notion that internal pricing serves both risk-management and signaling roles across industries. Together, the geographic and industry distributions underscore that ICP adoption is shaped by both external pressures - policy signals, investor expectations, and disclosure norms - and internal strategic considerations that differ across economic activities.

[Insert Figure 4 Here]

To better understand the heterogeneity across five ICP type, we examine the distribution and pricing of different ICP mechanisms by type. Panel A of Figure 5 shows that shadow price adopter dominates the landscape accounting for approximately 53% of all type-level ICP, followed by implicit prices (16.6%) and a much smaller share of internal fees, internal trading, and offsets. These differences in usage are mirrored by equally differences in price levels across types. Panel B of Figure 5 reports the median ICP price by type. Shadow prices again carry the highest median level ($33/tCO2e); Implicit prices, which embed marginal abatement costs into investment appraisal, follow at approximately ($27/tCO2e); Internal fees and internal trading prices lie in the mid-range ($20-22/tCO2e); and Offsets have the lowest median level, about $14/tCO2e, reflecting their link to historically lower-priced in global voluntray carbon markets.

[Insert Figure 5 Here]

Overall, the distribution and pricing of ICP types reveal that ICP is not a monolithic construct. Firms choose among mechanisms that differ fundamentally in purpose and pricing logic, ranging from strategic, forward-looking tools (shadow and implicit prices) to operational mechanisms (internal fees and trading) and market-based substitutes (offsets). Understanding these distinctions is essential for interpreting both the determinants and the consequences of ICP, as explored in the next sections.

4. The Determinants of ICP

Having documented the global patterns of ICP adoption, price levels, and pricing types, the cross-sectional patterns shown in the previous section suggest that ICP strategy varies widely across firms, yet the reasons behind this variation remain unclear. We now turn to the first core question: what drives firms to adopt an ICP and set its level? One view is that ICP reflects good governance practices and risk-based decision-making. Firms with agile boards, more active sustainability oversight, and greater exposure to transition risks may adopt ICP as part of a coherent strategy to integrate climate considerations into capital allocation. Under this hypothesis, corporate governance quality and climate risk exposure should be positively associated with both ICP adoption and higher price levels.

An alternative view is that ICP adoption is primarily symbolic, driven by external image building rather than governance and decisions. Firms might disclose the adoption of ICP without embedding them meaningfully into financial decisions, hence leading to the concern of greenwashing. If so, ICP adoption is not correlated with aspects of good governance or transition risks. To distinguish between these interpretations, we examine how board and stakeholder governance, carbon-transition risk exposure, and policy environments predict firms' ICP adoption and pricing decisions.

4.1 Effects of Board Structure and Stakeholder Governance

4.1.1 Regression Results

We then run the following OLS regression. The Equation (1) considers the impact of board governance, stakeholder governance, and other firm characteristics:

$$
\begin{aligned}
Y_{i,t+1} = {} & \beta_1 BoardGovernance_{i,t} + \beta_2 StakeholderGovernance_{i,t} + \beta_3 FirmControls_{i,t} \\
& + \delta_1 Country \times YearFE_{c,t} + \delta_2 Industry \times YearFE_{j,t} + \epsilon_{i,t} \qquad (1)
\end{aligned}
$$

$Y_{i,t+1}$ represents the dependent variable for firm i in year $t+1$, which is (i) *ICP Adopter*, (ii) *ICP Adopter by type*, (iii) *ICP Level* , or (iv) *ICP Level by type*. In the regression model analysing drivers of *ICP Adopter*, $Y_{i,t+1}$ represents a binary dummy variable where 1 indicates a firm i has adopted ICP in year $t+1$, and 0 denotes non-adoption. For the model examining *ICP Adopter by type*, $Y_{i,t+1}$ is a binary dummy where 1 indicates firm i adopting a specific ICP type, i.e. shadow price, implicit price, offset price, internal fee, or internal trading, in year $t+1$, with 0 indicating non-adoption of ICP price. For *ICP Level* model, $Y_{i,t+1}$ is the natural logarithm of the average ICP of firm i in year $t+1$. In the model dedicated to *ICP Level by type*, the dependent variable $Y_{i,t+1}$ represents the natural logarithm of firm i's specific ICP type, i.e., shadow price, implicit price, offset price, internal fee, or internal trading, in year $t+1$.

The control variable *Board Governance*$_{i,t}$ refers to a vector of lagged, time-varying corporate governance characteristics, which encompass metrics such as board size, board independence, the proportion of female directors, and the director majority election score. $Stakeholder\ Governance_{i,t}$ represents indicators related to stakeholder governance, including the environmental pillar score, the sustainability committee score, the sustainable reporting score, and the stakeholder engagement score. Finally, the firm-specific characteristics, denoted as $Firm\ Controls_{i,t}$, comprise factors such as firm size, leverage, profitability, cash holdings, asset tangibility, and the market-to-book ratio.

For fixed effects, we control for Country-year fixed effects as presented by $Country \times Year_{c,t}$, and Industry-year fixed effects as represented by $Industry \times Year_{j,t}$. This approach ensures that our findings are not disproportionately influenced by the unique conditions of a specific industry or country within a particular year. $\epsilon_{i,t}$ is the error term. Standard errors are clustered at both the firm and year levels in order to account for potential correlations within firms over time and across different years.

Table 4 presents the regression estimates for the determinants of firms' ICP adoption and levels. Columns (1)-(3) correspond to the adoption models, where the dependent variable is a dummy equal to one if firm i adopts an ICP in year t. Columns (4)-(6) report results for the price-level models, in which the dependent variable is the natural logarithm of the firm's average reported ICP level. Columns (1) and (4) focus on board governance variables, columns (2) and (5) on stakeholder governance variables, while columns (3) and (6) include the full set of explanatory variables. For all models presented, robust standard errors are clustered at the firm and year levels, enhancing the reliability of our inferences and ensuring a robust estimation framework for examining the determinants of ICP adoption. country-year and industry-year fixed effects are included in all models to account for temporal, sectoral, and geographical heterogeneity

[Insert Table 4 Here]

Across the adoption models (columns 1-3), board governance variables do not exhibit statistical significance in our baseline specification. This indicates that the structural composition of the board does not affect a firm's decision to adopt an ICP. In contrast, stakeholder-related factors appear more influential. The Environmental Rating shows a positive and economically meaningful association with ICP adoption, suggesting that firms with stronger environmental performance are more likely to introduce ICP. A one-unit improvement in environmental rating corresponds to approximately a 0.23 percentage-point higher probability of adoption. Stakeholder Engagement also exhibits a positive, albeit modest, relationship with ICP adoption.

Turning to the price-level models (columns 4-6), the results highlight a distinct set of drivers. Board Size is negatively and economically significant in relation to ICP levels. Specifically, smaller boards are associated with higher ICP: reducing board size by one member corresponds to an estimated 5.4% increase in ICP levels. This pattern suggests that firms with smaller, potentially more agile boards tend to assign higher values on carbon. Among stakeholder governance measures, the sustainability committee score has a positive economic effect on ICP levels. Among stakeholder-governance measures, the Sustainability Committee score exhibits a meaningful economic effect. The coefficient of 0.354% implies that a one-point increase in the score raises ICP prices by approximately 0.354%. Scaling the effect to a more realistic governance shift, a 10-point improvement is associated with \$ 1.75/tCO2e increase in ICP price *(*$10 \times 0.354\% \times 49.37$ (Avg ICP Price) = 1.75 *(\$/tonCO2e)*). This magnitude suggests that firms with stronger sustainability oversight adopt materially more stringent internal carbon benchmarks.

Overall, the evidence in Table 4 indicates that while the decision to adopt ICPs is primarily influenced by past environmental performance, the intensity of ICP pricing depends more on board size and structured sustainability governance. We further confirm that the results are robust to the exclusion of offset-related ICP types (see Table A3). These findings collectively highlight how internal and stakeholder governance mechanisms jointly shape not only the likelihood but also the stringency of firms' ICP strategies.

After analyzing the overall models for ICP adoption and price levels, we now turn to the type-specific results reported in Table A4. This disaggregated approach allows us to study the motivations and strategic considerations that influence the adoption of different type of ICP mechanisms within the corporate landscape[9].

Panel A of Table A4 shows that governance influences ICP adoption unevenly across different ICP types. Board Size is positively associated with the adoption of internal fee mechanisms, where an additional board member corresponds to around a 0.32 percentage-point higher likelihood of adoption. Board Independence is also positively related to internal fee adoption, though the effect is small. The presence of more female directors is associated with a slightly lower likelihood of adopting this particular type of ICP. This suggests that firms with larger boards and fewer female board members tend to adopt the unit-based fee type. Environmental Rating remains a driver, one-unit increase in environmental rating is associated with approximately a 0.17 and 0.07 percentage-point higher probability of adopting shadow pricing and internal fees, respectively.

Panel B shows clear differences in the governance drivers of ICP price-setting across types. Shadow prices are higher in firms with smaller boards, this again suggests that smaller, more agile boards tend to promote stricter internal carbon valuation. In contrast, firms operating under stronger shareholder accountability-proxied by a higher majority election score - set significantly lower prices for internal fees and internal trading mechanisms. Overall, these type-specific results highlight meaningful heterogeneity across ICP mechanisms. The results suggests that the influence of internal and stakeholder governance on ICPs is selective rather than uniform, shaping both adoption and pricing decisions in ways that align with firms' broader environmental commitments and management structures.

4.1.2 Country-Specific Determinants of ICP

Next, our analysis shifts to a jurisdiction level, focusing on the key drivers behind the price level of ICP. For this detailed investigation, we have selected the top 12 countries with the highest number of ICP adopters. Additionally, our selection criteria included jurisdictions with more than 38 firm-year observations, ensuring a robust and representative analysis[10]. The jurisdictions included

[9] Type- specific results are presented at Table A4. The models control for $Country \times Year_{c,t}$ and $Industry \times Year_{i,t}$ fixed effects, and the robust standard errors are clustered at both the firm and the year levels.

[10] The findings from this examination are presented in Table A5.

in this analysis are the United States of America, Japan, the United Kingdom, France, Republic of Korea, Canada, Germany, Taiwan, Spain, Switzerland, Italy, and the Netherlands.

A consistent pattern emerges for board size, which is negatively related to ICP levels in Japan, Canada, Switzerland, and Italy. The estimated magnitudes indicate that an additional board member is associated with approximately a 9-13 percent lower ICP on average, reinforcing the finding from the global model that smaller, more agile boards tend to assign higher carbon prices. This suggests that decision-making efficiency at the board level is particularly important in translating climate awareness into financially meaningful internal prices.

In terms of board independence, the relationships vary across country. While the variable is negatively associated with ICP levels in Spain, but positively associated in Italy. These contrasting patterns may reflect different national governance structures and regulatory contexts, wherein independent directors in Italy may view carbon pricing as a credible risk-management tool, whereas in Spain, greater independence could correspond to a more conservative stance toward internal pricing decisions.

Regarding female representation on boards, positive relationships with ICP levels are observed in the United Kingdom and Switzerland, while a negative association emerges in the Netherlands. The magnitudes suggest that a one-percentage-point increase in female board representation corresponds to approximately a 1.6-3.2 percent higher ICP in the UK and Switzerland, indicating that gender-diverse boards may be more inclined to support ambitious internal pricing strategies. In contrast, the negative relationship in the Netherlands implies that a one-percentage-point increase in female board representation is associated with approximately a 4 percent lower ICP.

Finally, environmental performance remains an important cross-country predictor. Higher environmental ratings are associated with higher ICP levels in Canada, Germany, and Spain, with a one-unit increase in environmental rating corresponding to approximately a 0.7 to 3.5 percent rise in ICP.

Taken together, these country-level findings reveal that while some governance mechanisms, particularly board size and environmental performance, exert a consistent influence across settings, other effects such as board independence and gender diversity are context-dependent. The heterogeneity across countries underscores the role of institutional environments and governance traditions in shaping firms' internal carbon pricing practices.

4.2 Effects of Corporate Carbon Transition Risk

To further measure the determinants of ICP levels, we focus on two important aspects of carbon transition risk: the influence of SBT and past emissions. The SBT variable serves as a proxy for firms' voluntary engagement with global decarbonization initiatives and reflects their readiness to align corporate strategies with scientifically defined emission-reduction pathways. In addition, Scope 1 and Scope 2 emissions capture direct and indirect emissions from firms' operations, respectively, while the changes in Scope 1 and Scope 2 emissions (S1C and S2C) measure the growth rate of annual emissions and provide a dynamic perspective on emission trends. The Equation (2) considers the impact of the carbon transition risks, while controling for board governance, stakeholder governance, and other firm characteristics:

$$
\begin{aligned}
Y_{i,t+1} &= \beta_1 SBT_{i,t} + \beta_2 Emissions_{i,t} + \beta_3 BoardGovernance_{i,t} + \beta_4 StakeholderGovernance_{i,t} \\
&\quad + \beta_5 FirmControls_{i,t} + \delta_1 Country \times YearFE_{c,t} + \delta_2 Industry \times YearFE_{j,t} + \epsilon_{i,t} \qquad (2)
\end{aligned}
$$

$Y_{i,t+1}$ represents the dependent variable for firm i in year $t+1$, which is (i) *ICP Adopter*, (ii) *ICP Adopter by type*, (iii) *ICP Level*, or (iv) *ICP Level by type*. In the regression model analysing drivers of *ICP Adopter*, $Y_{i,t+1}$ represents a binary dummy variable where 1 indicates a firm i has adopted ICP in year $t+1$, and 0 denotes non-adoption. For the model examining *ICP Adopter by type*, $Y_{i,t+1}$ is a binary dummy where 1 indicates firm i adopting a specific ICP type, i.e. shadow price, implicit price, offset price, internal fee, or internal trading, in year $t+1$, with 0 indicating non-adoption of ICP price. For *ICP Level* model, $Y_{i,t+1}$ is the natural logarithm of the average ICP of firm i in year $t+1$. In the model dedicated to *ICP Level by type*, the dependent variable $Y_{i,t+1}$ represents the natural logarithm of firm i's specific ICP type, i.e., shadow price, implicit price, offset price, internal fee, or internal trading, in year $t + 1$.

The variables of interest, $SBT_{i,t}$ and $Emissions_{i,t}$ capture two dimensions of firm's carbon transition risks. $SBT_{i,t}$ is a binary indicator that equals one if firm i has adopted a science-based target in year t, and zero otherwise. $Emissions_{i,t}$ represents the firm's historical carbon emission levels and includes multiple meaures: *Scope1 Emissions*, *Scope2 Emissions*.

The control variable $Board\ Governance_{i,t}$ refers to a vector of lagged, time-varying corporate governance characteristics, which encompass metrics such as board size, board independence, the proportion of female directors, and the director majority election score. $Stakeholder\ Governance_{i,t}$ represents indicators related to stakeholder governance, including the environmental rating, the sustainability committee score, the sustainable reporting score, and the stakeholder engagement score. Finally, the firm-specific characteristics, denoted as $Firm\ Controls_{i,t}$, comprise factors such as firm size, leverage, profitability, cash holdings, asset tangibility, and the market-to-book ratio. We also include the country-year, and industry-year fixed effects in our model to remove the influence of country-level macro shocks and industry-level time-varying factors..

Table 5 presents the determinants of ICP levels, examining both science-based targets and past emissions.

[Insert Table 5 Here]

The dummy variable SBT, indicating whether a firm has set a science-based target, shows significant positive coefficients for both ICP adoption (column 1 and 3) and the ICP price level(column 4 and 6). Specifically, the presence of an SBT is associated with a 14.46% increase in the likelihood of ICP adoption and an 18.51% increase in the ICP level. These results suggest that firms committed to science-based targets are more likely to adopt ICP and set higher prices, reflecting their proactive stance on environmental responsibility and carbon pricing.

Regarding the impact of past emissions on ICP adoption and pricing, the coefficient for Scope

1 emissions is positive and significant (1.86%) for ICP adoption, indicating that firms with higher direct emissions are more likely to adopt ICP. However, the relationship with the average ICP price is negative but insignificant.

The findings highlight the importance of setting science-based targets in driving both the adoption and higher pricing of ICP. Higher direct emissions (Scope 1) encourage ICP adoption. These results suggest that firms with clear environmental commitments (through science-based targets) and higher baseline emissions are more engaged in ICP mechanisms, but the dynamics of emission growth rates do not [11].

The type-specific results (as shown in Table A6) show that firms with science-based targets are substantially more likely to adopt shadow and implicit pricing mechanisms and tend to set higher implicit price and internal fee levels. Specifically, the presence of an SBT is associated with an 11 percentage-point higher likelihood of adopting shadow pricing and a 4 percentage-point higher likelihood of adopting implicit pricing. At the price level, firms with SBTs set internal carbon prices that are approximately 50% higher for implicit pricing and 47% higher for internal fee mechanisms. These magnitudes suggest that the commitment to measurable emission-reduction targets translates into more ambitious and financially meaningful internal pricing strategies.

Firms' direct operational emissions (Scope 1 emissions) also play a role in shaping type-specific ICP behavior. Higher Scope 1 emissions are associated with a modestly greater likelihood of adopting shadow pricing, with a one-unit increase in emissions corresponding to about a 1.6 percentage-point higher probability of adoption. At the pricing stage, firms with higher Scope 1 emissions tend to set substantially higher offset levels - on average about 35 percent higher - suggesting that carbon-intensive firms internalize greater carbon costs once they implement offset mechanisms.

This section concludes that firms with science-based targets are more likely to adopt ICP and set higher prices. Firms with higher direct emissions are more likely to adopt ICP mechanisms in general. The varying influences of Scope 1 and Scope 2 emissions on different ICP types provide

[11] Table A6 presents insight into the determinants of ICP adoption and price by each type

insights into how companies prioritize and manage their ICP.

4.3 National Climate Policies

So far, our analysis has focused on the effect of firm characteristics by using country-year fixed effects to absorb the effects of macroeconomics conditions and policy changes. To further study how external carbon policies affect internal carbon pricing, we exploit quasi-natural experiments induced by changes in national carbon policies in three countries, i.e. the US, UK, and Canada.

To mitigate potential biases and address the issue of endogeneity in our analysis, we employed propensity score matching (PSM) to create a more comparable control group. Specifically, we applied the nearest neighbor matching method with a one-to-one ratio and without replacement. In this matching process, we used a logistic regression model to estimate the propensity scores. The propensity scores were calculated using a set of variables that included both board governance and firm characteristics.

4.3.1 Difference-in-Difference Regressions

To examine how ICP adoption and price-setting outcomes evolve following the issuance of the national climate policies, we estimate a difference-in-differences specification using all firm-year observations of the treated and matched control firms from 2014-2021. The regression is shown below:

$$\begin{aligned} Y_{i,t} &= \beta_1 Treatment_i + \beta_2 Post_t + \beta_3 (Treatment_i \times Post_t) + \beta_4 FirmControls_{i,t} \\ &\quad + \delta_1 CountryFE_c + \delta_2 Industry \times YearFE_{j,t} + \epsilon_{i,t} \end{aligned} \tag{3}$$

where i indexes firms, t indexes years, c indexes countries, j indexes ICB industries, $Treatment_i$ is a dummy variable that equals one if firm i is located in a country affected by the event or policy and zero otherwise, $Post_t$ is another dummy variable that equals one if a policy or event has been announced in year t and zero otherwise. $Y_{i,t}$ is the outcome variable of interest (e.g., *ICP Adopter* or *ICP Level*). The coefficient of interest is β_3, which measures the difference-in-differences in outcome variable $Y_{i,t}$ between treated and matched control firms. In other words, β_3 measures the change in $Y_{i,t}$. $FirmControls_{i,t}$ are set of firm controls, $Country\ FE_c$ are country fixed effects, $Industry \times Year\ FE_{j,t}$ are industry by year fixed effects. ϵ_{it} is the error term. We cluster standard errors at both firm and year levels.

4.3.2 The US Withdrawal of the Paris Agreement in 2017

As the second event of interest, we examine the impact of the US's announcement to withdraw from the Paris Agreement in 2017. This policy change under the Trump administration had significant implications for climate change engagement in the US, potentially reducing the incentives for firms to adopt the ICP.

The Paris Agreement, established in 2015, was a landmark international agreement aimed at addressing climate change by limiting global warming to well below $2°C$ above pre-industrial levels. The US, as one of the world's largest economies, played a critical role in the initial formation and commitment to the Paris Agreement. However, in June 2017, the Trump administration announced its intention to withdraw the US from the agreement, signalling a significant shift in the country's stance on climate policy. This decision effectively reduced the regulatory pressures and incentives for firms to adopt stringent environmental practices, including the implementation of ICP mechanisms.

The withdrawal from the Paris Agreement represents a considerable policy shock with broad implications for firms operating within the US. The announcement sent a message that the federal government would not enforce the same level of commitment to reducing greenhouse gas emissions, potentially leading firms to de-prioritize or scale back their environmental initiatives. As such, examining the impact of this policy shift allows us to understand how firms adjust their environmental strategies in response to changes in the external regulatory environment, particularly in the context of reduced incentives for carbon pricing mechanisms.

[Insert Table 6 Here]

The empirical results, presented in Table 6, shed light on the drivers behind ICP adoption (Column 1) and ICP price levels (Column 2) for the US firms, following the US's withdrawal from the Paris Agreement. The negative and significant coefficient for the $Post * Treated$ variable indicates that the announcement of the US withdrawal had a notable negative impact on the adoption of ICP. Firms in the US were less likely to adopt ICP mechanisms and following the reduced regulatory pressures after 2017. This reflects a shift in corporate behavior in response to the federal government's reduced emphasis on climate change mitigation efforts.

4.3.3 The Climate Policy Shocks in the UK and Canada

This subsection investigates the impact of the UK's 2019 legislation enacting the 2050 net-zero GHGs target and Canada's introduction of the federal Output-Based price System (OBPS) affects the adoption and price of ICP among UK and Canadian companies.

The UK is a home to one of the most stringent and ambitious climate policy regimes in the world (Gransaull, Rhodes, and Fairbrother, 2023; Hendry, 2020). A central piece of that regime is the 2008 Climate Change Act (CCA), which committed the UK to reducing its greenhouse gas emissions by 80% by 2050 compared to 1990 levels, formed the Committee on climate change, and established UK carbon budgets. In June 2019, this was strengthened, committing the UK to bring all GHGs to Net Zero target by 2050. Thus, the UK became the first major economy in the world to pass laws to end its contribution to global warming by 2050.

This legislative framework represents a significant policy shock with far-reaching implications for firms operating within the UK (Averchenkova, Fankhauser, and Finnegan, 2021). The amendment to the CCA in 2019 sent a clear signal to businesses that the long-term trajectory of the UK economy would be towards decarbonization. As such, firms were compelled to reassess their environmental strategies and adopt measures that would align with the newly established legal requirements. One such measure is the adoption and implementation of ICP, a mechanism that allows firms to internalize the cost of carbon emissions and align their financial and environmental objectives.

The introduction of this policy provides a quasi-exogenous shock to the regulatory environment in which firms operate. By testing the impact of the 2019 CCA amendment on ICP adoption and pricing, we can better understand how firms respond to external regulatory pressures. Additionally, by examining this policy shock, we explore the differential effects on ICP adoption and pricing across firms with varying levels of board and stakeholder governance.

We further examine how Canada's introduction of the federal Output-Based Price System (OBPS) affects the adoption and price of ICP among Canadian companies. The OBPS was established with the objective of implementing carbon pricing in all provinces and territories of Canada. The purpose of this design is to reduce GHG emissions from industrial sources, while also minimising the possibility of carbon leakage and ensuring that Canadian industries remain competitive. The implementation of the OBPS serves as a policy change that has a direct impact on the financial and environmental decision-making processes of companies operating in Canada.

The investigation seeks to identify whether these policies has driven companies to adopt ICP more rigorously and if it has impacted the pricing strategies associated with carbon costs. The regression results, presented in Table 6, provide insights into the drivers behind ICP adoption (Column 3) and ICP price levels (Column 4) in the context of the UK's policy shock, and the adoption of ICP (Column 5) and the pricing levels of ICP (Column 6) for Canadian companies in reaction to the policy shock. The $Post \times Treatment$ variable represents the difference between the treatment and control groups before and after the implementation of the target policy.

The results for UK policy indicate that this interaction term is not statistically significant in either the ICP adopter or ICP level models, with coefficients of -0.022 and -0.036, respectively. This suggests that the policy shock did not directly lead to a significant increase in ICP adoption or a rise in ICP pricing levels following 2019. This finding may reflect the possibility that, in the short term, while the policy conveyed a clear long-term signal for emission reduction, companies may require more time to adjust and respond to this policy when formulating and revising their ICP strategies. The coefficient for the variable $Post \times Treatment$ indicates a value of 0.083 and 0.071

for Canadian firms, respectively, although insignificant. This suggests that, while there may be a directional tendency toward increased ICP adoption and higher price levels following the OBPS rollout, the policy shock did not lead to a measurable or systematic change in firms' internal carbon pricing behaviour during the sample period.

5. Internal Carbon Pricing and Financial Performance

In this section, we shift from analysing the determinants of internal carbon pricing to assessing whether ICP affects firm performance. Our focus is on whether ICP changes how firms perform, invest, and are valued by financial markets.

We first consider firm profitability. ICP could support future profits by helping firms anticipate climate-related risks, impose internal discipline on carbon-intensive activities, and signal credible sustainability commitments. At the same time, internal carbon charges may reduce short-run earnings if they divert capital away from highly profitable but polluting projects or introduce additional frictions when implementation is opaque or weakly enforced. The net impact on profitability is therefore ambiguous ex ante.

We then examine two broader dimensions of effectiveness. At the firm level, we study whether ICP is associated with systematic shifts in capital expenditures across business segments, consistent with ICP being used as a genuine decision tool rather than a purely symbolic policy. In financial markets, we ask whether investors reward or penalise firms with ICP, while allowing for the possibility that any valuation effects are too small or noisy to generate strong statistical signals.

Taken together, these analyses evaluate whether ICP affects operations, internal resource allocation, and market perceptions. Section 5.1 begins by examining the relationship between ICP and future profitability.

5.1 Internal Carbon Price and Firm Profitability

5.1.1 Regression Results

This subsection examines the relationship between ICP and firm profitability, measured using ROA and OPM. ROA is calculated as EBIT margin times revenue and then divided by the value of total asset, while OPM is measured as the EBIT margin, both on a quarterly basis. Equation (4) below evaluates the impact of ICP on a firm's profitability over the next one or two quarters, analyzing how the previous year's ICP adoption or price levels affect the financial outcomes.

$$\begin{aligned} Profitability_{i,t+k} = \beta_0 + \beta_1 ICP_{i,t} + \beta_2 FirmControls_{i,t} + \delta_1 Country \times YearQuarterFE_{c,t} \\ + \delta_2 Industry \times YearQuarterFE_{j,t} + \epsilon_{i,t} \end{aligned} \tag{4}$$

Where $Profitability_{i,t+k}$ represents the financial performance indicator for firm i at time t, which can be either *ROA* or *OPM* . k can be 1 for the next quarter or 2 for the quarter after that. $ICP_{i,t}$ represents the adoption, or ICP level for firm i at time t. For the model of ICP adoption, $ICP_{i,t}$ is a binary dummy where 1 indicates firm i adopting the ICP, 0 otherwise. For the ICP level model, $ICP_{i,t}$ is the natural logarithm of the average ICP level of firm i in at time t. *FirmControls* controls for the size of firm i at time t, measured as total assets and BM Ratio, which is the book-to-market ratio of firm i at time t.[12] For fixed effects, we control for Country-year-quarter fixed effects as presented by $Country \times YearQuarter_{c,t}$, and Industry-year-quarter fixed effects as represented by $Industry \times YearQuarter_{j,t}$. $\epsilon_{i,t}$ is the error term.

The analysis incorporates two models: Table 7 Panel A evaluates the effect of ICP adoption (a binary indicator), and Table 7 Panel B examines the influence of ICP price levels among adopters.

[Insert Table 7 Here]

[12] To account for potential effects of capital investment on *ROA* and *OPM* measurements, we also include CapEx-to-assets in an untabulated robustness check. The results remain virtually unchanged, confirming the robustness of our findings.

Panel A of Table 7 reports a negative and statistically significant association between ICP adoption and both profitability measures. Firms that adopt an internal carbon price experience a modest decline in profitability, with a reduction in *ROA* of 0.052 percentage points one year ahead and 0.056 two years ahead—both significant at the 1% level. The effect on *OPM* is larger, with decreases of 0.403 and 0.417 percentage points, significant at the 1% and 5% levels, respectively. Economically, these effects correspond to approximately 2.8% ($0.052 \div 1.833 \approx 2.8\%$) of the sample mean for *ROA* and 2.9% ($0.403 \div 13.989 \approx 2.9\%$) for *OPM*, indicating a non-trivial short-term financial impact. These patterns suggest that while ICP adoption may reflect a firm's sustainability commitment, it is associated with short-term profitability costs, possibly reflecting implementation efforts or early adjustments related to the transition process.

In contrast, Panel B shows that the level of internal carbon pricing does not significantly affect either *ROA* or *OPM*. The coefficients are close to zero and statistically insignificant, suggesting that it is the decision to adopt an internal carbon price—rather than the specific price magnitude—that is related to firm performance outcomes.

To further examine heterogeneity, we split the sample by country income level based on the World Bank classification. As reported in Table A7, firms in both developed and developing economies experience lower profitability following ICP adoption, particularly in terms of *OPM*. The magnitude of the decline is stronger in developing markets, where firms may face tighter financial or resource constraints. Consistent with the full sample, ICP price levels remain insignificant across both subsamples.

Overall, these findings indicate that internal carbon pricing imposes measurable short-term costs on firm profitability. While ICP adoption is associated with lower ROA and OPM, the pricing level itself does not exhibit a significant impact. This evidence reinforces that the decision to adopt ICP, rather than the chosen internal price, drives the short-term financial effects observed across firms.

5.1.2 Results by Industry and Country

To further examine heterogeneity in the relationship between ICP and firm-level profitability, we estimate one-year-ahead ROA coefficients by industry and by jurisdiction, as presented in Figure 6 and Figure 7, respectively. The results reveal substantial cross-sectional variation in the effects of both ICP adoption and ICP price levels.

[Insert Figure 6 Here]

Panel A of Figure 6 reports the estimated ROA coefficients for ICP adoption across industries. The coefficients are generally small and statistically insignificant, with one notable exception: the Real Estate sector shows a positive and significant effect. This result suggests that ICP adoption in this sector may coincide with favorable regulatory conditions or structural characteristics that align with emission-intensive activities. Panel B presents the results for ICP price levels. Although the overall effect is not statistically significant, the Technology sector exhibits positive estimates, while Telecommunications displays negative ones. These sectoral differences indicate that the profitability implications of ICP are not uniform and may depend on differences in carbon intensity and operational flexibility across industries.

[Insert Figure 7 Here]

Turning to the jurisdiction-level results, Figure 7 shows one-year-ahead ROA coefficients by jurisdiction. Panel A illustrates that the United States and Turkey exhibit negative and statistically significant coefficients for ICP adoption, implying short-term profitability declines in these markets.

For most other jurisdictions, the coefficients are statistically indistinguishable from zero, suggesting more muted effects. Panel B focuses on ICP price levels, where Turkey, Sweden, and Thailand show negative and significant coefficients. These findings suggest that higher internal carbon prices are associated with lower near-term profitability in certain markets, whereas in most others, the effects remain small and statistically insignificant.

5.1.3 Effects on Capital Reallocation

The firm-level analysis in Table 7 shows that firms adopting ICP experience a short-term decline in profitability, consistent with early-stage transition adjustments. To understand where these costs originate, we turn to the allocation of capital expenditures across business segments. Because capital expenditures directly affect asset utilization and thus returns on assets, while their influence on operating profit margins is more indirect, we focus on ROA as a more direct and transparent channel through which ICP may affect investment behavior.

We use US segment-level data from Compustat, where each segment corresponds to a major business division as reported in the firm's financial statements. After merging these data with our main sample, we obtain a U.S. subsample comprising 155 to 261 firms per year (over the period 2014-2021), with an average of 4.32 segments per firm per year. This dataset allows us to examine how the capital-expenditure intensity of each division responds to profitability following ICP adoption.[13] Specifically, we regress segment CapEx on the interaction between ICP measures and segment-level return on assets (ROA_s). Because the Compustat Segment data restrict our analysis to a U.S. subsample with a limited number of ICP-adopting firms, we focus on the adoption indicator and do not conduct separate tests based on ICP price levels. The regression model is shown below in Equation (5) and Equation (6):

$$\begin{aligned}CapEx_{s,t+1} = \beta_0 + \beta_1 ICP\_Adopter_{i,t} \times ROA_{s,t} + \beta_2 ICP\_Adopter_{i,t} + \beta_3 ROA_{s,t} + \\ \beta_4 SegmentControls_{s,t} + \beta_5 FirmControls_{i,t} + \delta_1 FirmFE_i + \delta_2 YearFE_t + \epsilon_{s,t}\end{aligned} \tag{5}$$

[13] Compustat segment-level capital expenditures and assets do not sum to firm-level totals due to the exclusion of corporate and unallocated components. As a result, capex-related measures at the segment level may not be directly consistent with firm-level metrics.

$$
\begin{aligned}
CapEx_{s,t+1} = \beta_0 &+ \beta_1(ICPAdopter_{i,t} \times ROA_{s,t} \times SmallBoard_{i,t}) \\
&+ \beta_2(ICPAdopter_{i,t} \times ROA_{s,t}) + \beta_3(ICPAdopter_{i,t} \times SmallBoard_{i,t}) \\
&+ \beta_4(ROA_{s,t} \times SmallBoard_{i,t}) + \beta_5 ICPAdopter_{i,t} + \beta_6 ROA_{s,t} + \beta_7 SmallBoard_{i,t} \\
&+ \beta_8 SegmentControls_{s,t} + \beta_9 FirmControls_{i,t} + \delta_1 FirmFE_i + \delta_2 YearFE_t + \epsilon_{s,t}
\end{aligned} \tag{6}
$$

Where $CapEx_{s,t+1}$ represents the capital expenditure intensity of the segment s in year $t+1$. $ICP\_Adopter_{i,t}$ is a binary dummy where 1 indicates firm i adopting the ICP, 0 otherwise. $ROA_{s,t}$ is the segment-level return on assets (*ROA*) at time t . Following *SegmentControls* are included: lagged segment capital expenditure intensity for segment s in year t, segment size measured by the natural logarithm of the segment total capital, segment age measured by the difference between year t and the first time when the segment is listed in the dataset. *FirmControls* controls for the size of firm i at time t, measured as total assets or total revenue, BM Ratio, which is the book-to-market ratio of firm i at time t, leverage and cash of firm i at time t. Firm fixed effect and year fixed effect are controlled in the model, and $\epsilon_{s,t}$ is the error term.

Equation (5) captures whether ICP adoption alters the sensitivity of divisional investment to profitability. Equation (6) extends this framework by interacting ICP adoption and profitability with a dummy variable, $Small\ Board_{i,t}$, which equals one for firms with below-median board size in a given year, to examine whether board structure moderates this reallocation effect.

[Insert Table 8 Here]

Columns (1) to (3) of Table 8 report a negative and statistically significant association between the interaction term $ICP\ Adopter_{i,t} \times ROA_{s,t}$ and next-year segment-level capital expenditure ($CapEx_{s,t+1}$). The negative coefficient -0.023 ($p < 0.05$) indicates that, following ICP adoption, a one-standard-deviation increase in ROA_s is associated with a 1.18% ($0.023 \times 51.353 \approx 1.18$) decline in a division's capital expenditure intensity, which represents about 25.6% ($1.18 \div 4.616 \approx 25.6\%$)

of the sample mean. Economically, these results imply that after introducing an internal carbon price, firms allocate relatively less capital to divisions with higher returns on assets, which mechanically leads to a decline in the firm's aggregate ROA. This pattern is likely consistent with a partial reallocation of investment away from mature, possibly carbon-intensive operations toward emerging or transitional business segments.

In columns (4) to (6) of Table 8, we further incorporate a governance dimension by interacting ICP adoption with both segment-level profitability and a small-board-size dummy. The dummy equals one for firms whose board size is below the U.S. median in a given year. The triple-interaction coefficient $\textit{Small Board}_{i,t} \times \textit{ICP Adopter}_{i,t} \times \textit{ROA}_{s,t}$ is -0.042, which is negative and statistically significant ($p < 0.05$), indicating that the negative sensitivity of divisional capital expenditure to profitability is significantly stronger for firms with smaller boards. Quantitatively, this coefficient implies that, relative to firms with larger boards, ICP-adopting firms with below-median board size allocate an additional 2.16% ($0.042 \times 51.353 \approx 2.16$) less capital to high-ROA divisions—a difference corresponding to approximately 46.8% ($2.16 \div 4.616 \approx 46.8\%$) of the sample mean divisional capital expenditure intensity. This pattern suggests that more compact boards—often associated with stronger monitoring and quicker decision-making—facilitate internal capital adjustments once environmental pricing mechanisms are introduced. The result highlights that corporate governance structures can condition the effectiveness of internal carbon pricing in shaping firms' investment behavior.

Overall, the segment-level evidence provides a microfoundation for the firm-level findings. The short-run profitability losses documented in Table 7 stem from a shift in internal capital allocation that reduces investment in high-return divisions. While this reallocation likely contributes to firms' long-term transition efforts, its immediate effect is to depress firm-level ROA, highlighting the limited but tangible trade-offs embedded in the early stages of internal carbon pricing implementation.

5.2 Internal Carbon Price and Stock Returns

5.2.1 Regression Results

This section evaluates whether ICP adoption or pricing levels influence future stock returns. While prior sections suggest a weak association between Internal Carbon Price and accounting-based profitability measures, the market's response remains unclear. To address this, we examine monthly stock returns using three return measures: raw returns, industry-adjusted returns, and market-adjusted returns[14]. Equation (7) presents the baseline regression specification.

$$
\begin{aligned}
R_{i,t+1} = \; & \beta_0 + \beta_1 ICP_{i,t} + \beta_2 FirmControls_{i,t} + \beta_3 CountryControls_{c,t} \\
& + \delta_1 CountryFE_c + \delta_2 YearmonthFE_t + \epsilon_{i,t}
\end{aligned} \tag{7}
$$

Where $R_{i,t+1}$ is the stock return for firm i at time $t+1$, which may be adjusted for industry or market effects. $ICP_{i,t}$ represents either the adoption dummy or the level of ICP implemented by firm i at time t. For the model of ICP adoption, $ICP_{i,t}$ is a binary dummy where 1 indicates firm i adopting the ICP, 0 otherwise. For the ICP price model, $ICP_{i,t}$ is the natural logarithm of the average ICP of firm i in at time t. $FirmControls_{i,t}$ includes the following set of control variables: the firm size, the book-to-market ratio of a firm one month prior, the dividend yield, cumulative return in the previous months, dollar trading volume, stock price, the standard deviation of the residual from regressing excess returns for the firm between months *t-13* and *t-2* on the excess stock market return, and the absolute returns over trading volume for the firm between months *t-13* and *t-2*. $CountryControls_{c,t}$ includes the GDP growth, GDP per capita, stock market capitalization over GDP taken, and the inflation rate. *Country* FE_c and *Yearmonth* FE_t indicates the country- and time-fixed effects. $\epsilon_{i,t}$ is the error term.

Table 9 presents the results for ICP adoption and price levels.

[14] The raw return is the stock return for the firm. Industry-adjusted return is measured by the difference between the raw return of the stock and the average industry return in which the firm is located in the same month. Market-adjusted return is calculated using the stock return minus the market return of the market (country) of the firm in the same month.

[Insert Table 9 Here]

Panel A of Table 9 reports the association between ICP adoption and subsequent stock returns. Columns (1) to (3) present the results for raw returns, showing that the coefficients on ICP Adoption remain statistically insignificant across all specifications, with or without firm- and country-level controls. Similar results are observed in columns (4) to (6), where industry-adjusted returns are used as the dependent variable, and in columns (7) to (9), where the dependent variable is market-adjusted returns. Panel B of Table 9 examines the relationship between ICP Level and stock returns. Consistent with Panel A, the coefficients on ICP Level are small in magnitude and insignificant across all model specifications. Overall, the evidence shows that neither the adoption nor the level of internal carbon pricing is associated with differences in subsequent stock returns. This suggests that investors did not exhibit a statistically significant reaction to ICP-related information during the sample period.

To examine whether the results vary across different market environments, we further split the sample by country income group based on the World Bank classification. The corresponding estimates are presented in Table A8.

Table A8 reports the results separately for developed and developing countries. Across both subsamples, the coefficients on ICP Adoption and ICP Level remain economically small and statistically insignificant for all return measures. Including firm-level controls, macroeconomic variables, and fixed effects does not materially change the results. These findings indicate that the absence of a return effect is not driven by cross-country heterogeneity or differences in market maturity.

Taken together, the results reinforce the main evidence that investors in both developed and developing markets do not display a systematic pricing response to firms' internal carbon pricing policies. The lack of significance across subsamples suggests that ICP information was not perceived as return-relevant during the period of analysis.

5.2.2 *Portfolio Sorting Results by Industry and Country*

We further evaluate the market pricing of ICP strategies using a long-short portfolio approach. Firms are sorted into two groups: ICP adopters (long) and non-adopters (short). Portfolios are value-weighted and rebalanced annually. We also construct long-short portfolios based on ICP price levels, sorting firms into quintiles.[15] Returns are evaluated using the Carhart four-factor model, which controls for market, size, value, and momentum effects. Monthly alphas and significant levels are reported in Figure 8 (industry level) and Figure 9 (country level).

[Insert Figure 8 Here]

[Insert Figure 9 Here]

The industry-level analysis provides limited evidence of significant alphas related to ICP adoption or price levels. In Panel A of Figure 8, the results show no statistically significant effects across industries, indicating that ICP adoption has little impact on risk-adjusted returns once market and style factors are controlled for. Panel B of Figure 8, which examines ICP price levels, shows a similar pattern: most industries display insignificant alphas, except for the Technology sector, where the alpha is positive and significant. For other industries, the effects are negligible. Overall, these results suggest that the influence of ICP on stock returns is not uniformly distributed across industries and may depend on sector-specific characteristics.

The country-level results reported in Figure 9 reveal notable cross-country variation in the financial impact of ICP. The Carhart four-factor estimates highlight both the heterogeneity and the complexity of ICP's effect on risk-adjusted returns. While industry-level effects are limited, the country-level analysis shows distinctive patterns.

[15] Specifically, stocks are ranked into quintiles according to their internal carbon price. The fifth quintile contains firms with the highest ICP price level and the first quintile those with the lowest. The remaining stocks are split equally into portfolios 2-4. The long-short trading strategy takes a long position in the fifth-quintile portfolio and a short position in the first-quintile portfolio.

In the Netherlands, ICP adoption is associated with significantly negative returns, whereas among adopters, higher ICP levels correspond to positive but statistically insignificant alphas, suggesting some offsetting effect.[16] Panel B of Figure 9 further shows that the effects of ICP levels on stock returns differ across countries. For instance, firms in Germany exhibit higher alphas associated with higher ICP levels, whereas Swiss firms show lower returns under similar conditions. These results indicate that the pricing of internal carbon pricing varies across markets.

6. Does ICP reduce future emissions?

We now turn from financial outcomes to the environmental implications of internal carbon pricing. The impact of ICP on firm-level emissions is theoretically ambiguous. Internal carbon charges may encourage cleaner operations and shift investment away from carbon-intensive activities, yet ICP can also be adopted by firms anticipating higher emissions or used in ways that do not directly constrain emission-intensive production. Whether ICP ultimately raises or lowers emissions is therefore an empirical question.

In the short run, however, ICP is unlikely to produce immediate reductions in total emissions. As a voluntary and internally designed mechanism, ICP is more plausibly reflected in how emissions evolve rather than in their overall level. Firms may slow the growth of emissions or improve carbon efficiency even when aggregate emissions remain stable or increase. Guided by this perspective, we examine three complementary measures of future emissions: Scope 1 emission growth (Δ *Scope1*), Scope 1 emission intensity (*Scope1 Intensity*), and Scope 1 emission levels (*Scope1*),[17] where short-run effects may operate in either direction. The empirical specification is presented in Equation

[16] For the Netherlands, the four-factor alpha in Panel A is negative and statistically significant, while the corresponding estimate in Panel B is positive but insignificant, indicating weaker underperformance among firms with higher ICP levels.

[17] Definitions of the emission measures are provided in Table A1.

(8).

$$Emission_{i,t+k} = \beta_0 + \beta_1 ICP_{i,t} + \beta_2 LaggedDependentVariable_{i,t} + \beta_3 FirmControls_{i,t} + \delta_1 Country \times YearFE_{c,t} + \delta_2 Industry \times YearFE_{j,t} + \epsilon_{i,t} \quad (8)$$

The dependent variable, $Emission_{i,t+k}$, represents firm i's carbon emission outcomes at time $t + k$, where $k = 1$ or 2 denotes one-year-ahead or two-year-ahead effects. Specifically, we examine Scope 1 emission growth (Δ *Scope1*), Scope 1 emission intensity (*Scope1 Intensity*), and Scope 1 emission levels (*Scope1*). The independent variable $ICP_{i,t}$ represents either ICP adoption (binary indicator) or the logged ICP levels, capturing the extent of firms' ICP mechanisms. The term $FirmControls_{i,t}$ includes variables such as leverage, capital expenditure, and earnings variability to control for firm-level factors influencing emission outcomes. Fixed effects $Country \times Year\ FE_{c,t}$ and $Industry \times Year\ FE_{j,t}$ account for unobserved heterogeneity at the country-year and industry-year levels, respectively, over time. The error term $\epsilon_{i,t}$ captures unexplained variability in the emission outcomes.

[Insert Table 10 Here]

Panel A of Table 10 reports the results for ICP adoption. The coefficient on ICP adoption is negative and statistically significant for one-year-ahead and two-year-ahead Scope 1 emission growth. The estimated effects correspond to reductions of approximately 0.051 and 0.058 units, respectively. implying a 0.05%-0.06% decrease (22%-25% of the average) in the annual rate of Scope 1 emissions growth. In contrast, the coefficients for Scope 1 emission intensity and Scope 1 emission levels are statistically insignificant, suggesting that ICP adoption slows the growth of emissions but does not materially alter carbon efficiency or total emission levels in the short run.

Panel B turns to the results using ICP price levels. The coefficient on Scope 1 emission intensity is negative and statistically significant: a 1% increase in the ICP price is associated with an estimated 3.4% reduction in one-year-ahead intensity, indicating improved carbon efficiency. For Scope 1 emission levels, the coefficient is positive and significant, with a 1% increase in the ICP price corresponding to a 1.5% rise in direct emissions. This positive association is not surprising, as total emissions tend to move with production activity and may rise even as firms improve efficiency. Overall, ICP price levels appear more systematically linked to reductions in carbon intensity than to changes in absolute emission levels.

Taken together, the results in Table 10 indicate a mixed environmental effect of internal carbon pricing. ICP adoption modestly reduces the growth rate of emissions, and higher ICP price levels are associated with improved carbon efficiency but also with higher absolute emissions. These findings suggest that ICP on its own has limited impact on reducing overall emissions, and meaningful decarbonization likely requires complementary measures such as regulatory incentives, technology upgrades, and deeper integration of sustainability objectives into firm operations.

7. Conclusion

This paper provides the first global evidence on what drives internal carbon pricing and whether it delivers measurable financial or environmental effects, employing data from 54 jurisdictions between 2014 and 2021. Using data from the CDP disclosures complemented by manually constructed classifications of ICP types for the earlier sample, we show that firms' board and stakeholder governance structures and external policy environments jointly shape ICP behavior. In particular, firms with a smaller board or committed to science-based targets set higher levels of ICP, while the US withdrawal from the Paris Agreement reduced the likelihood of ICP adoption by US firms. The evidence suggests that internal carbon pricing is not a 'dark art' exercised by firms merely to enhance corporate image. We find that ICP adoption correlates with several aspects of corporate governance and climate policy that one would expect to influence corporate decisions on sustainability.

ICP is not a 'free lunch' for firms, though: it reduces firm profitability in the short term. Using segment-level data for US firms, we find that ICP shifts capital allocation internally, where capital is reallocated away from the most profitable business divisions, consistent with lower firm-level profitability when firms invest in the low-carbon transition. We do not find that ICP significantly affects risk-adjusted returns for investors, suggesting that the effect of ICP on profits is priced in by the stock market. Further, we find that ICP adoption leads to slower growth in emissions. While adopters with higher ICP levels have lower emission intensity, their total emissions continue to rise, implying that these firms have not yet reached the peak level of carbon footprints in their green transition.

Overall, our evidence suggests that internal carbon pricing contributes to the low-carbon transition by integrating climate into corporate finance decisions. The findings imply that achieving meaningful decarbonization is likely to require complementary measures such as stricter regulatory standards, technological innovation, and broader integration of sustainability into corporate strategy - alongside voluntary internal carbon pricing initiatives.

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Figure 1: Trend of company coverage by ICP Adoption type from 2014 to 2021

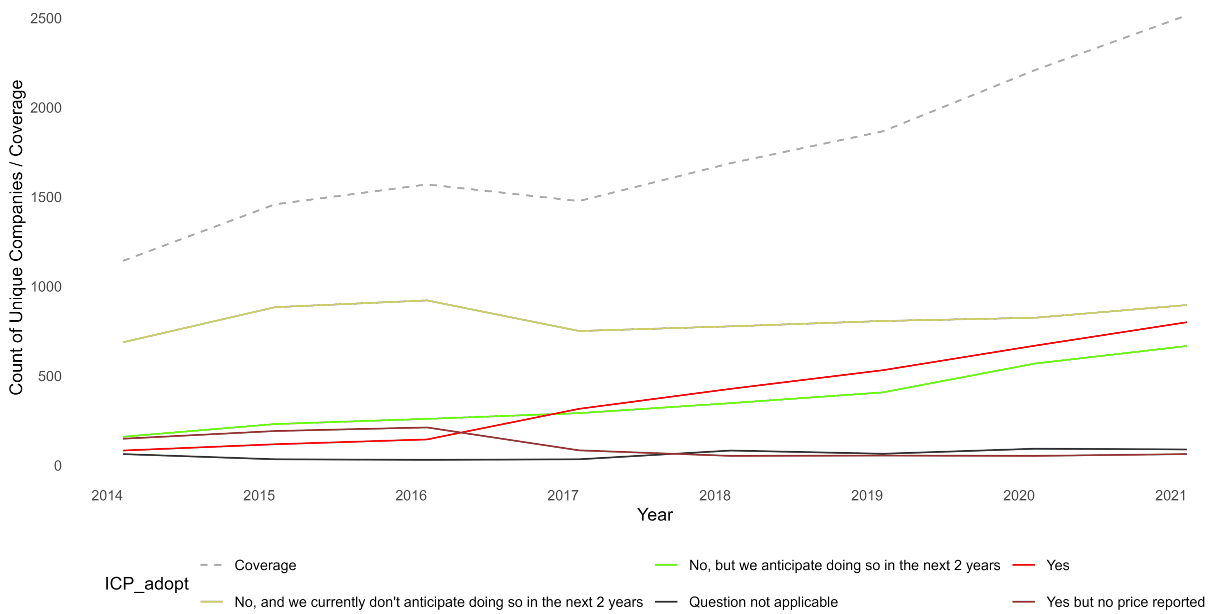


Figure 2: Number of companies engaged with ICP across countries and continents

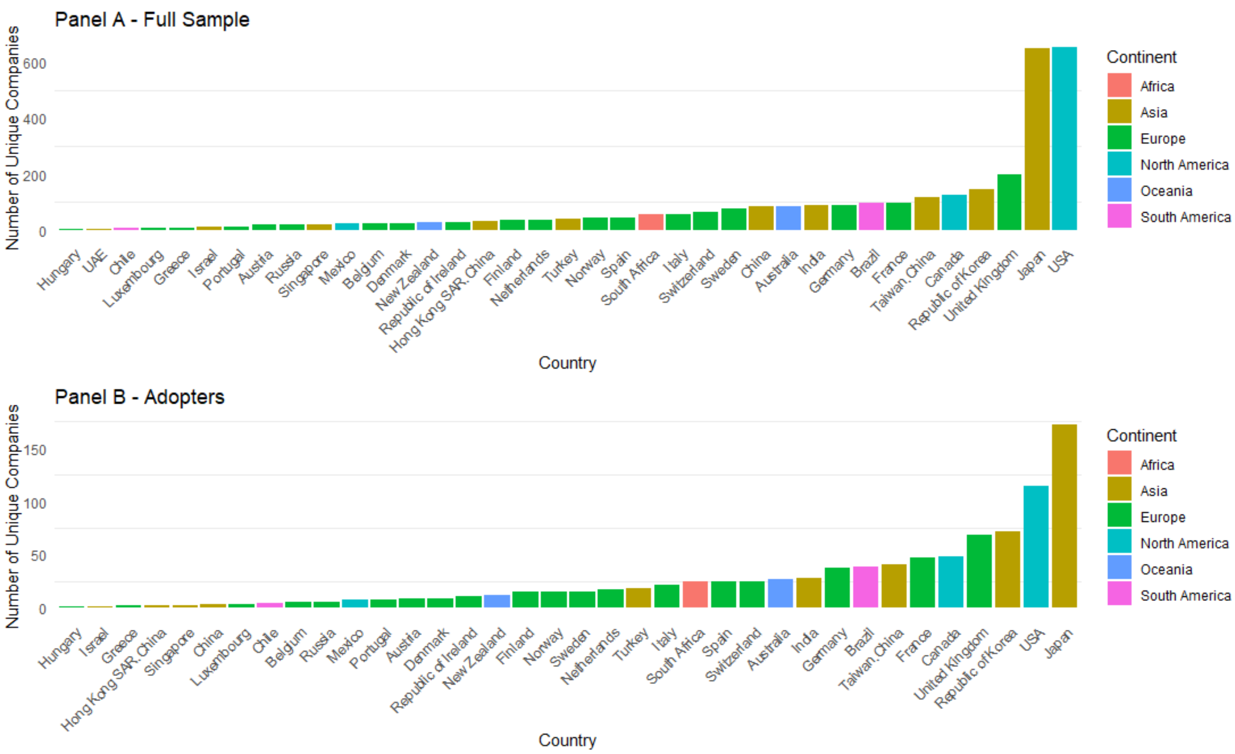


Figure 3: Number of unique companies engaged with ICP across ICB industries

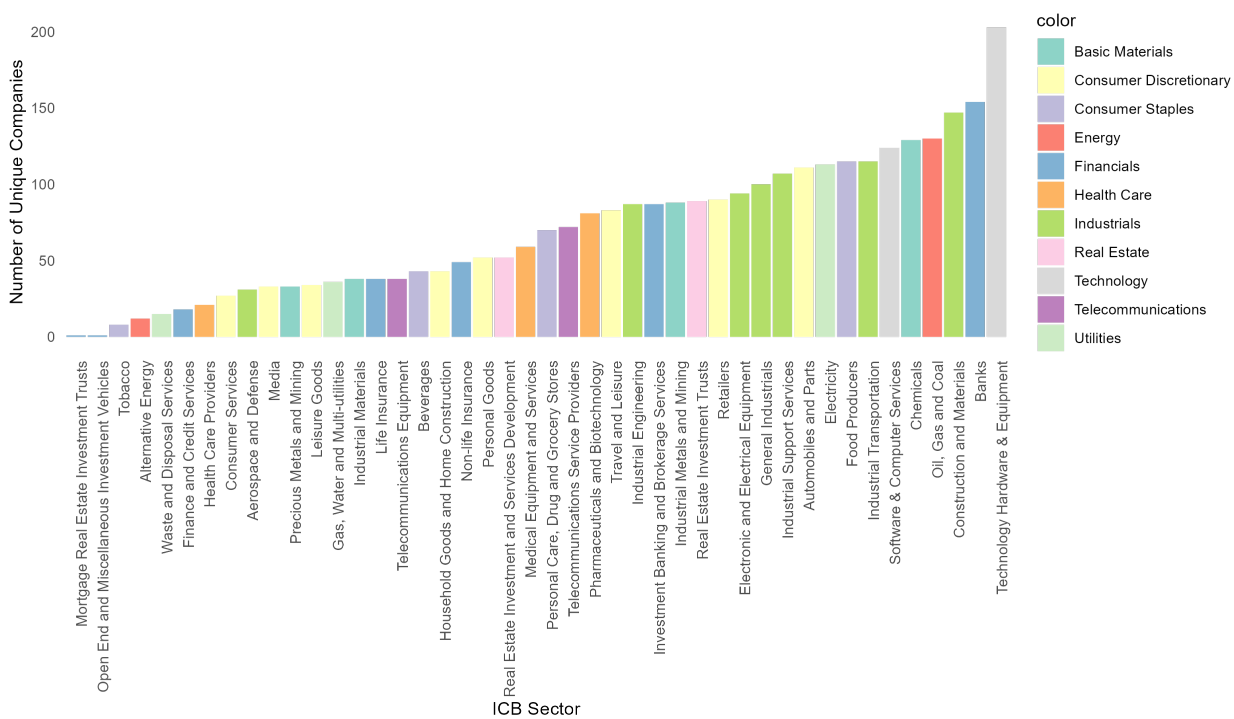


Figure 4: Average ICP Price per ICB Industry

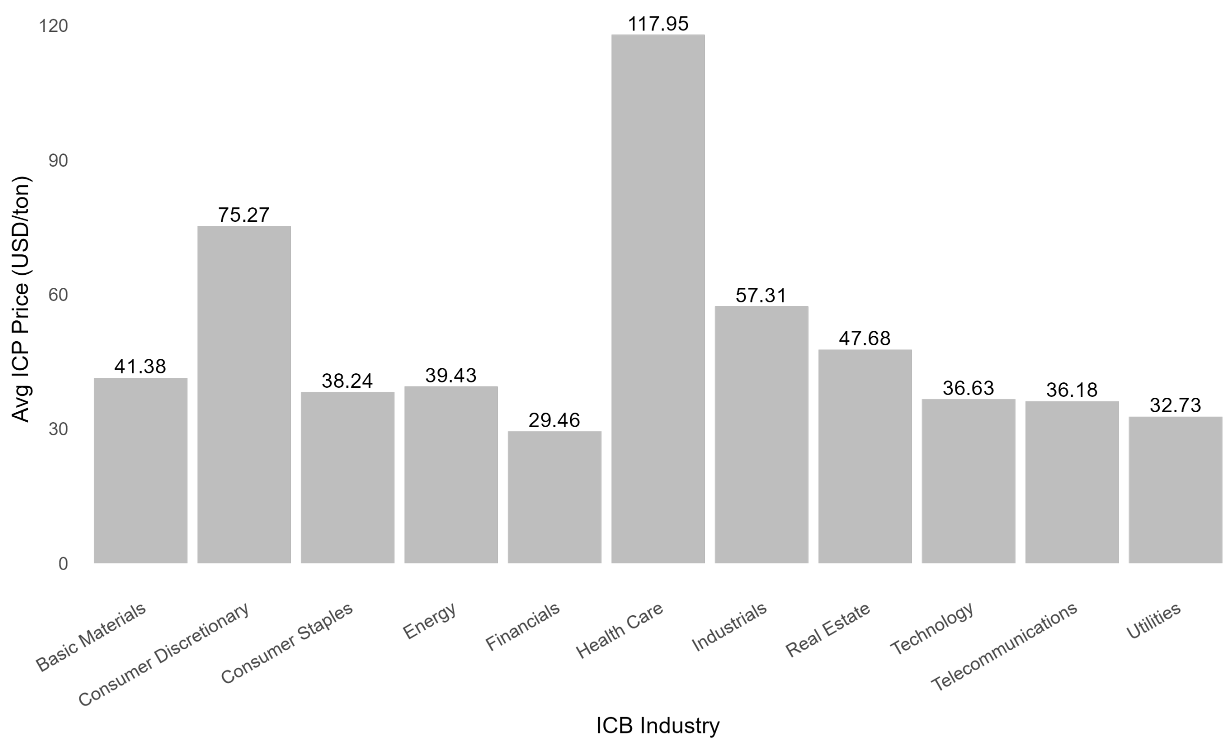
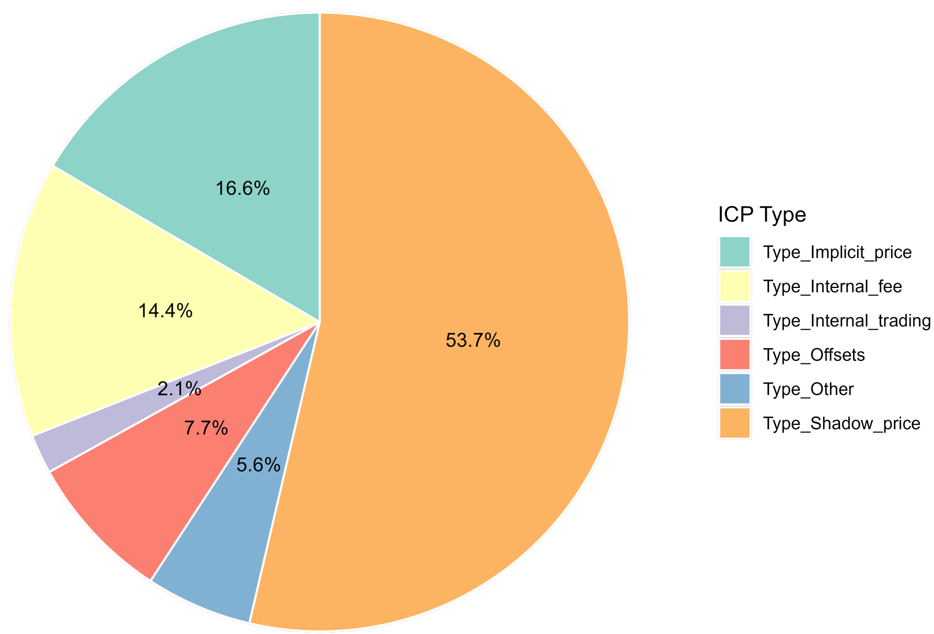
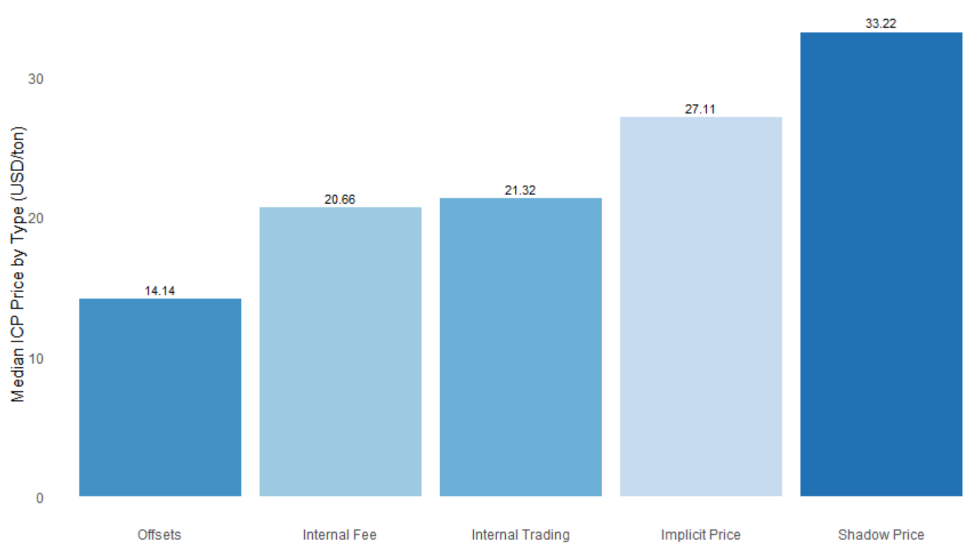


Figure 5: Distribution of ICP adopter and median ICP price by ype



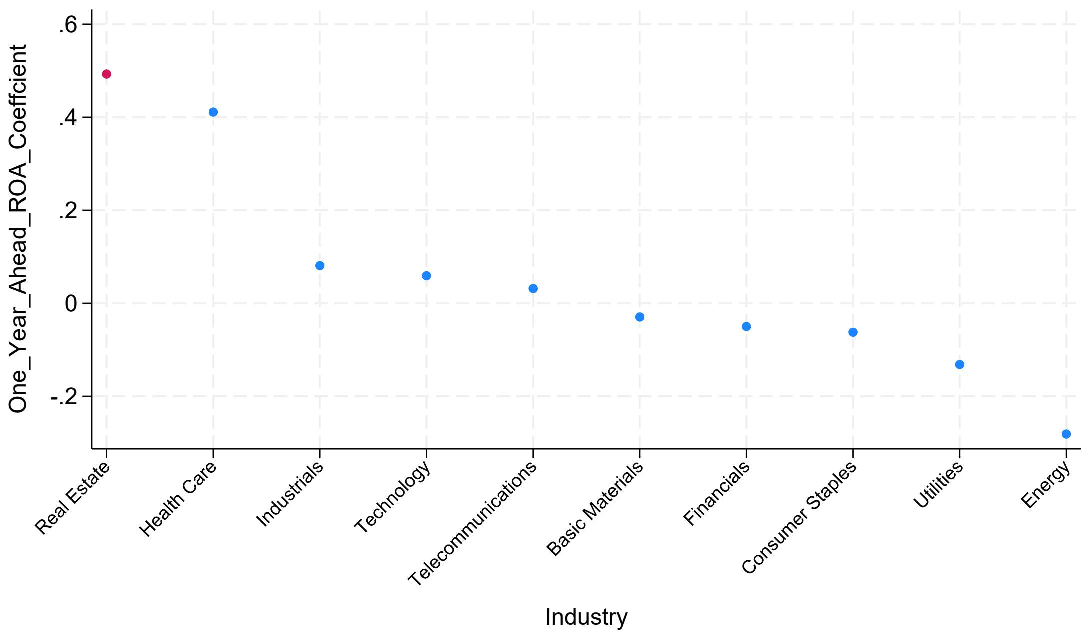
Panel A: Distribution of adopters across ICP types



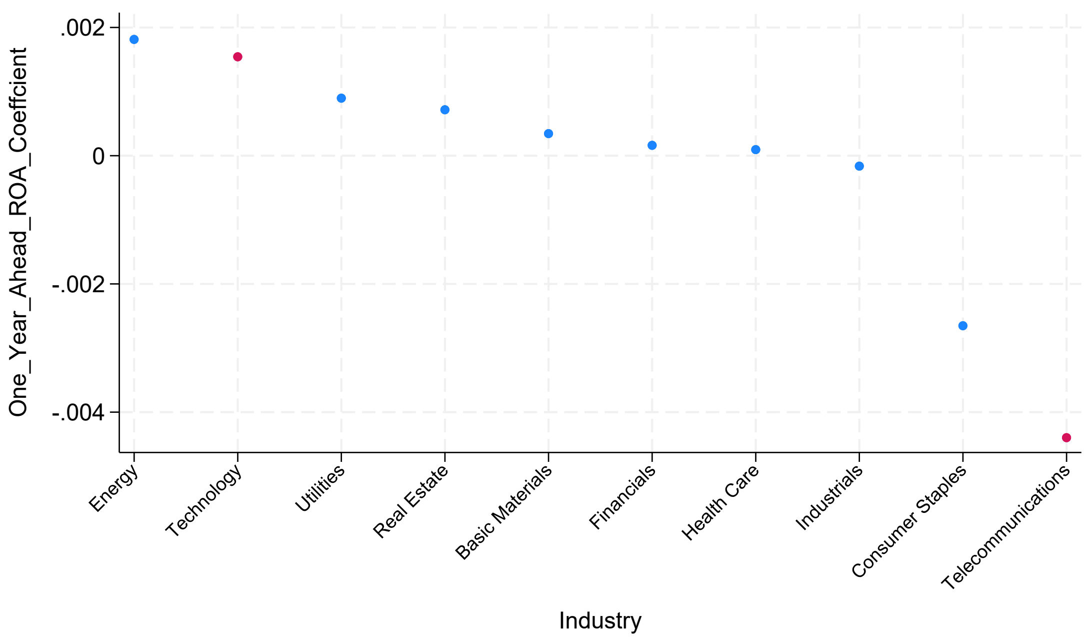
Panel B: Median price for six ICP types

Figure 6: ROA One Year Ahead Coefficient by Industry

These figures show the coefficients of one-year-ahead ROA, regressed on the *ICP Adopter* (Panel A) and *ICP Level* (Panel B) using different industry subsamples. We exclude those quarters when there are less than 5 firms listed in the industry i. The coefficients are shown in red dots if the p-value is lower than 10% and blue otherwise. Country × year-quarter fixed effect is included in the models. Standard errors are clustered at the firm and time levels. The estimation period is from 2012 to 2021.



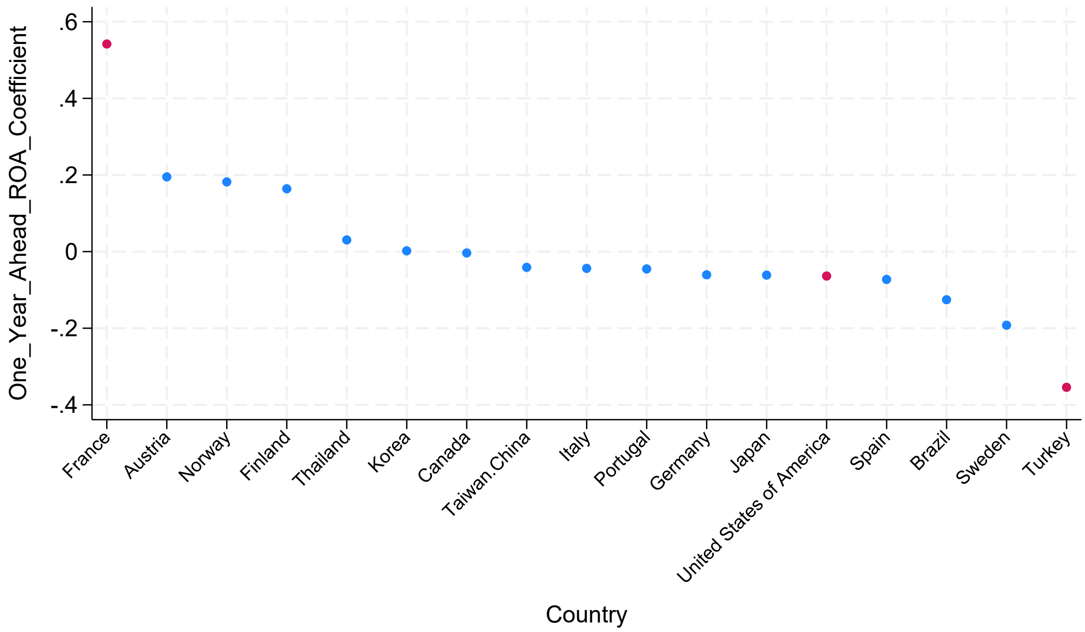
Panel A: ROA One Year Ahead Coefficient by Industry - ICP Adopter



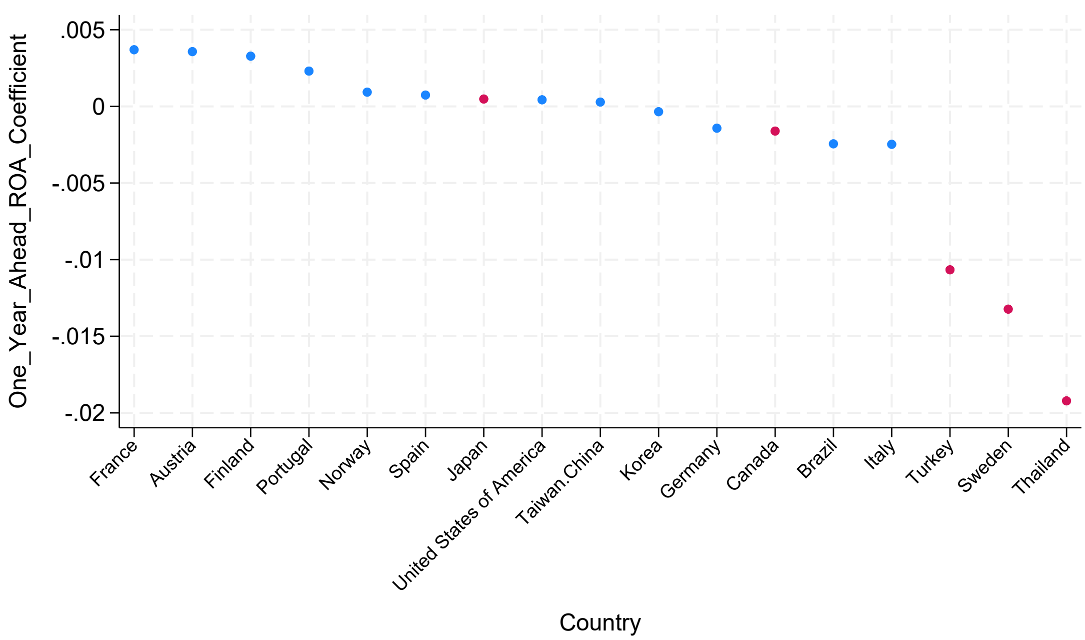
Panel B: ROA One Year Ahead Coefficient by Industry - ICP Level

Figure 7: ROA One Year Ahead Coefficient by Country

These figures show the coefficients of one-year-ahead ROA, regressed on the *ICP Adopter* (Panel A) and *ICP Level* (Panel B) using different country subsamples. We exclude those quarters when there are less than 5 firms listed in the country i. The coefficients are shown in red dots if the p-value is lower than 10% and blue otherwise. Country × year-quarter fixed effect is included in the models. t-statistics are adjusted using . The estimation period is from 2012 to 2021.



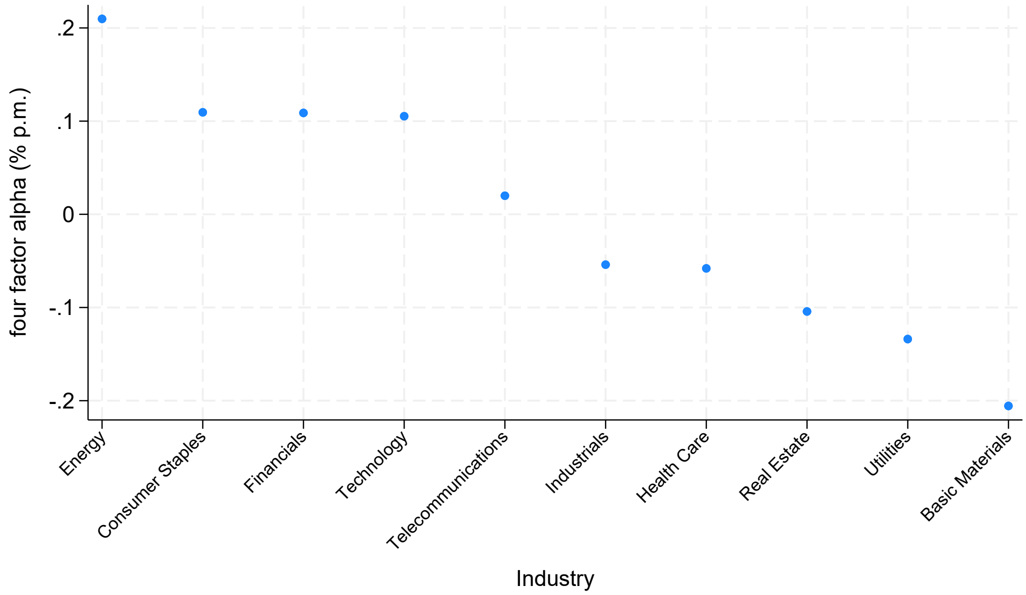
Panel A: ROA One Year Ahead Coefficient by Country - ICP Adopter



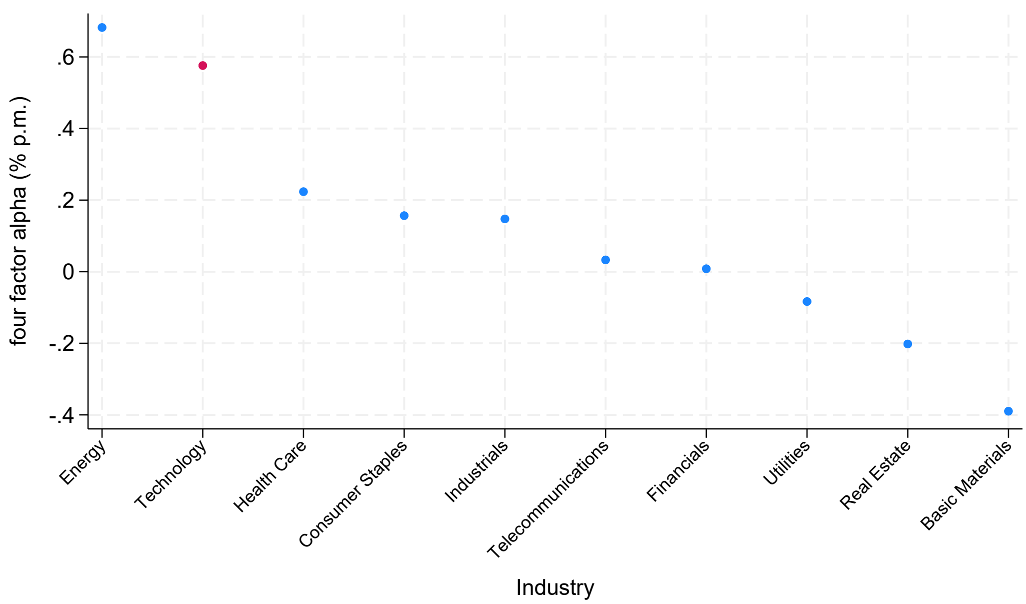
Panel B: ROA One Year Ahead Coefficient by Country - ICP Level

Figure 8: Four-factor-Alpha by Industry

This figure shows the monthly Four-Factor-Alpha difference for portfolios sorted by *ICP Adopter* and *ICP Level* portfolio using different industry subsamples. We applied the following filters in the model: First, for each industry i, we exclude those months when there are less than 10 firms listed in the industry i. Then, we will only report industry i if the remained sample period is no less than 36 months (3 years) after applying the first filter. We present the alpha difference using ICP Adoptor minus Non-ICP Adopotor in Panel A and the alpha difference using High-ICP level portfolio minus the Low ICP Level portfolio. The alpha differences are shown in red dots if the p-value is lower than 10% and blue otherwise. *t*-statistics are computed using **?** adjusted standard errors. The estimation period is from 2012 to 2021.



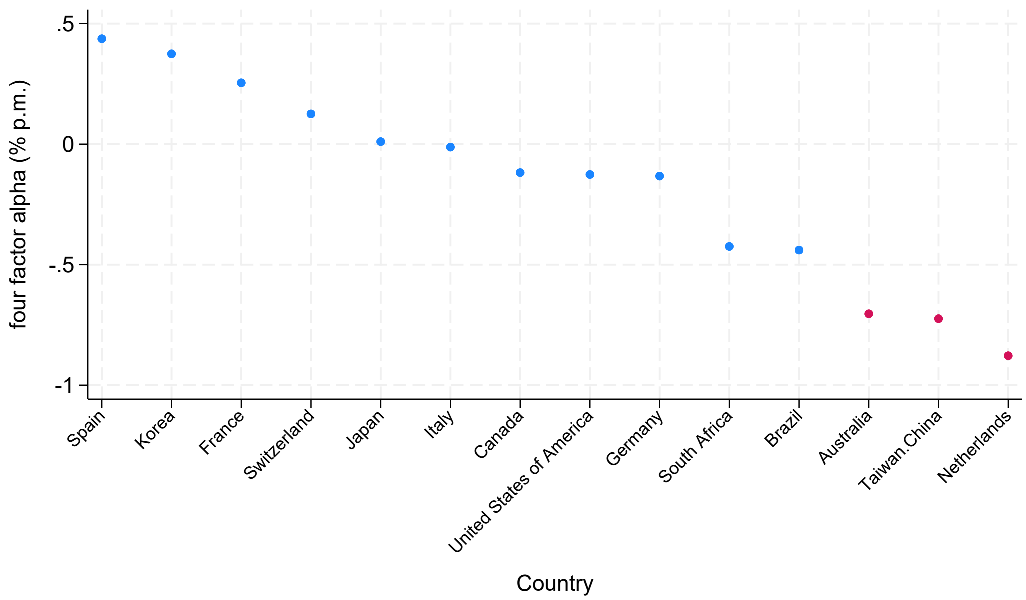
Panel A: Four-factor-Alpha by Industry: ICP Adopters Minus Non-Adopters



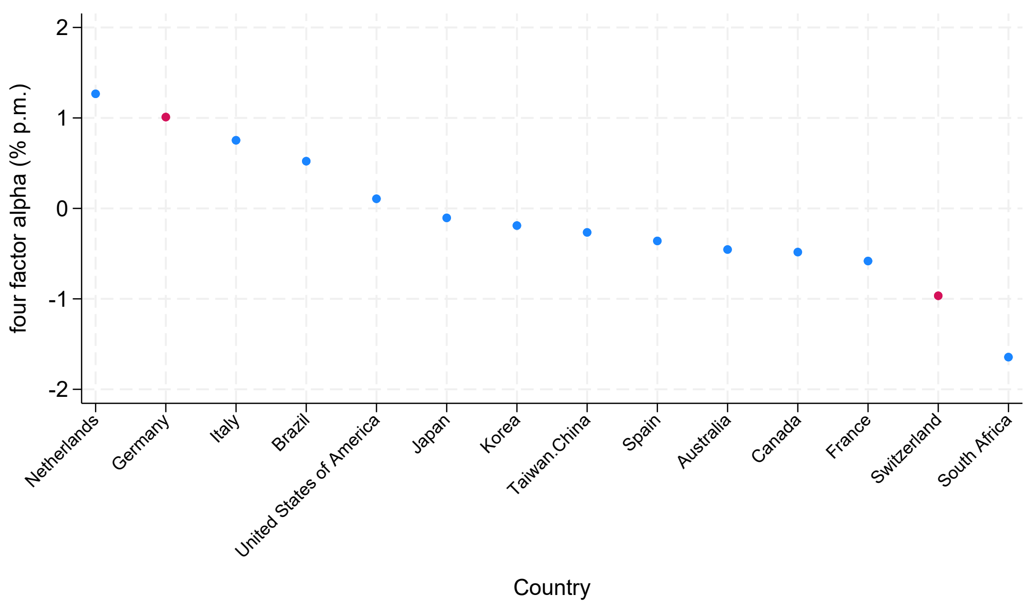
Panel B: Four-factor-Alpha by Industry: High ICP Level Minus Low ICP Level

Figure 9: Four-factor-Alpha by Country

This figure shows the monthly Four-Factor-Alpha difference for portfolios sorted by *ICP Adopter* and *ICP Level* portfolio using different country subsamples. We applied the following filters in the model: First, for each country i, we exclude those months when there are less than 10 firms listed in the country i. Then, we will only report country i if the remained sample period is no less than 36 months (3 years) after applying the first filter. We present the alpha difference using ICP Adoptor minus Non-ICP Adopotor in Panel A and the alpha difference using High-ICP level portfolio minus the Low ICP Level portfolio. The alpha differences are shown in red dots if the p-value is lower than 10% and blue otherwise. *t*-statistics are computed using **?** adjusted standard errors. The estimation period is from 2012 to 2021.



Panel A: Four-factor-Alpha by Country: ICP Adopters Minus Non-Adopters



Panel B: Four-factor-Alpha by Country: High ICP Level Minus Low ICP Level

Table 1: An Overview of Internal Carbon Price Studies

Reference	Study Area	Study Period	Focus	Findings
Zhu, Xu, Wang, and Zhang (2022)	500 US listed firms	2011-2018	ICP impact on firm environmental performance	ICP reduces firms' emission intensity
Ma and Kuo (2021)	Europe, North America, Asia	2013-2017	ICP impact on asset return	ICP increased return on assets (ROA) by 1.1%
Trinks, Mulder, and Scholtens (2022)	CDP countries	2014-2017	Policy stringency and firm characteristics affect ICP adoption	Policy stringency and firms' exposure to explicit carbon pricing systems increase ICP adoption. ICP use is strongly and positively related to firm size, environmental performance, and carbon emissions.
Bento and Gianfrate (2020)	CDP countries	2015-2017	Determinants of ICP levels	Climate policy, country development, industry, and corporate governance determine ICP levels.
Byrd, Cooperman, and Hickman (2020)	CDP countries	2015-2018	ICP impact on emission intensity	The adoption of ICPs reduces emissions for industries with high emissions and high capital costs, but the effect is not significant for the entire sample.
Bento, Gianfrate, and Aldy (2021)	CDP countries	2016	Explicit carbon pricing facilitates ICP adoption	ICPs are significantly higher in countries that price carbon explicitly.
Ben-Amar, Gomes, Khursheed, and Marsat (2022)	CDP countries	2016-2018	Climate change exposure increases ICP adoption	The probability of ICP adoption is largely linked to regulatory shocks and opportunity exposure. Moreover, board independence acts as a moderator in the climate change exposure-ICP adoption relationship.
Kuo and Chang (2021)	Japan	2016-2019	ICP impact on carbon management reputation	Implementation of ICP improves firms' carbon management reputation

Table 2: Definitions, Mechanisms, and Cases of Different Type of Internal Carbon Price Used

Panel A: Definitions and Mechanisms

ICP Type	Definition	How is it financed	Mechanism	Pros	Cons
Shadow Price	A hypothetical cost of carbon to reveal hidden risks and opportunities throughout its operations and supply chain.	No additional budget required	Encourages investments and purchases that favour low-carbon options	Facilitates a long-term transition to low-carbon investments and purchases	Effectiveness is difficult to verify without tangible cash flow
Implicit Price	It helps quantify the capital investments required to meet climate-related targets	Requires additional budget	Funds technology upgrades within the firm	Directly achieves emission reductions	The additionality of emission reductions needs to be verified
Internal Fee	A per-unit fee based on the amount of GHG the company emits.	No additional budget required	Raises employee awareness and uses funds collected for low-carbon investments	Generates a clear cash flow	Effectiveness depends on how the collected funds are used; more suitable for large firms with department-specific budgeting
Offsets	The price to purchase offset credits externally. This involves purchasing carbon offsets or credits to compensate for the carbon emissions produced by an organization	Requires additional budget	Purchases offset credits to neutralize the firm's emissions	Simple to implement	Does not encourage internal emission reductions; quality of offset credits can be uncertain
Internal Trading	It allows business units within a company to trade their allocated carbon credits based on respective emissions	No additional budget required	Implements a market mechanism within the firm, similar to an Emissions Trading System (ETS)	Encourages innovative approaches to emission reduction through market incentives	High management costs to establish and maintain a carbon budget and a reasonable carbon price

Table 2: Definitions and Cases of Different Type of Internal Carbon Price Used (Continued...)

	Panel B: Case Study
Shadow Price	Shell integrates ICP as a shadow price into its strategic planning, setting a project screening value that evolves into country-specific future carbon costs estimates. This approach serves as a stress test for investments, aligning with the global shift towards a low-carbon economy.
Implicit Price	Anglian Water uses an implicit carbon pricing approach in its £2 billion capital investment programme, favouring low-carbon projects for their environmental and cost-saving benefits, effectively valuing carbon reduction at approximately £300 per tonne of CO_2e.
Internal Fee	Société Générale Bank Group introduced an internal carbon fee at €10/tCO_2 from 2014 to 2021, incentives business units to reduce emissions and adopt energy-efficient practices by integrating carbon costs into their financial framework.
Offsets	The ICP in Royal Bank of Canada has seen significant adjustments, with carbon offset prices increasing from $ CAD 0.44 per tonne in 2019 to $ CAD 10.49 per tonne in 2021, reflecting a substantial rise in the cost of high-quality carbon offsets certified by the United Nations and other respected registries.
Internal Trading	Stora Enso incorporates real EU ETS market prices into its internal CO2 trades, driving investments in CO_2-neutral technologies and fuel switching, demonstrating a sophisticated application of internal carbon trading.

Table 3: Summary Statistics

This table reports the summary statistics for the variables in this paper. Panel A reports the Internal Carbon Price-related variables. Panel B and Panel C show the firm-level and division-level variables, respectively. Carbon transition risk variables are shown in Panel D. All the variables are defined in Table A1.

Panel A: Internal Carbon Price Variables

	N	Mean	Std Dev.	p25	p50	p75	Frequency
ICPAdopter	8604	0.254	0.435	0.000	0.000	0.000	Year
ICP($/tonCO2e)	2157	49.340	81.830	10.943	28.555	55.974	Year
ICP Level	2157	3.300	1.130	2.450	3.367	4.029	Year
Shadow Price	1525	46.160	45.760	15.000	33.218	57.692	Year
Implicit Price	403	63.120	146.380	11.303	27.112	47.277	Year
Offsets	157	23.260	37.850	2.492	14.657	26.867	Year
Internal Fee	346	51.710	102.360	5.796	20.659	39.433	Year
Internal Trading	40	24.610	17.130	12.455	21.317	29.622	Year
Other	127	42.410	45.560	7.952	28	58.128	Year

Panel B: Firm Level Variables

	N	Mean	Std Dev.	p25	p50	p75	Frequency
Board Size	8604	11.007	3.100	8.000	11.000	13.000	Year
Board Independence (%)	8604	61.051	26.253	33.333	64.286	84.615	Year
Female (%)	8604	20.495	13.567	8.333	20.000	30.000	Year
Majority Election (%)	8604	48.869	30.764	0.000	60.550	74.373	Year
Environmental Rating (%)	8604	61.705	21.296	43.115	64.869	78.572	Year
Sustainability Committee (%)	8604	60.849	27.560	55.556	68.075	76.356	Year
Sustainability Report (%)	8604	59.121	29.165	52.151	64.286	80.165	Year
Stakeholder Engagement (%)	8604	55.353	34.987	0.000	69.712	81.298	Year
Cash (%)	8604	9.185	7.843	2.647	7.089	12.890	Year
Leverage (%)	8604	22.612	14.394	9.717	21.176	31.460	Year
Asset Tangibility (%)	8604	61.686	45.665	19.843	53.145	91.111	Year
Market_to_book	8604	1.837	1.833	0.614	1.226	2.265	Year
ROA(%)	38927	1.833	1.781	0.645	1.534	2.620	Quarter

	N	Mean	Std Dev.	p25	p50	p75	Frequency
OPM (%)	39572	13.989	14.763	5.376	10.942	19.845	Quarter
Size	38927	22.725	1.538	21.620	22.740	23.810	Quarter
BM Ratio	38927	0.701	0.627	0.269	0.526	0.930	Quarter
Return	101395	1.189	9.202	-4.000	0.947	5.996	Month
Industry – Adj Return	101395	0.084	7.585	-4.372	-0.155	4.079	Month
Market – Adj Return	101395	0.350	7.791	-4.316	0.024	4.553	Month
Dividend Yield	101395	0.512	0.919	0.000	0.074	0.693	Month
*Ret*2_3	101395	5.867	8.274	0.000	2.077	9.106	Month
*Ret*4_6	101395	7.726	10.246	0.000	3.599	12.206	Month
*Ret*7_12	101395	12.037	15.325	0.000	6.602	18.736	Month
Trading Volume Volume	101395	2.559	7.847	0.000	0.364	1.556	Month
Price	101395	50.236	67.474	10.704	27.864	62.302	Month
IDIOVOL	101395	10.136	0.870	9.526	9.868	10.507	Month
ILLIQ	101395	0.000	0.000	0.000	0.000	0.000	Month
Capex (%)	29355	1.160	1.074	0.430	0.870	1.567	Quarter

Panel C: Division Level Variables

	N	Mean	Std Dev.	p25	p50	p75	
Capex (%) (Division)	4297	4.616	6.341	1.26	3.152	6.156	Year
ROA (%) (Division)	4297	6.289	51.353	3.137	8.671	16.499	Year
Size (Division)	4297	8.122	1.684	6.968	8.141	9.326	Year
Division Age	4297	10.764	6.235	5.000	9.000	16.000	Year

Panel D: Carbon Transition Risk

	N	Mean	Std Dev.	p25	p50	p75	
SBT	8604	0.141	0.348	0.000	0.000	0.000	Year
*Scope*1 *Emission*	5312	11.943	2.837	9.587	11.852	13.838	Year
Scaled Scope1 Emission	3806	1.133	3.174	0.010	0.050	0.476	Year
*Scope*2 *Emission*	5312	11.922	2.066	10.277	12.155	13.409	Year
*S*1*C*	5312	0.229	3.387	-0.848	0.000	0.650	Year

Table 4: Determinants of Internal Carbon Pricing: Adoption vs. Price

This table reports OLS estimates for firm-level financial variables on *ICP Adopter* (columns 1-3) and *ICP Level* (columns 4-6). *ICP Adopter* is a dummy variable where one indicates a firm adopted ICP in a given year, and zero otherwise. *ICP Level* is the natural logarithm of the average ICP level ($ton CO2e) of various types of ICPs in a given year. All right-hand side variables (in Equation (1)) are lagged by one year. All coefficients are multiplied by 100 for ease of interpretation. Findings are robust to excluding offset types (see Table A3). For the price-level regressions (columns 4-6), variables are winsorized at the 1st and 99th percentiles. $Country \times Year$ and $Industry \times Year$ fixed effects are included in the models. Standard errors are clustered at the firm and time levels, and t-statistics are reported in parentheses below the estimates. The estimation period is from 2014 to 2021. All the variables are defined in Table A1. ($*$ $p < 0.10$, $**$ $p < 0.05$, $***$ $p < 0.01$)

	ICP Adopter			**ICP Level**		
	(1)	(2)	(3)	(4)	(5)	(6)
Board Size	0.247		0.054	−5.444***		−5.359***
	(0.79)		(0.18)	(−4.00)		(−4.16)
Board Independence	0.078		0.056	0.234		0.192
	(1.52)		(1.06)	(1.23)		(1.05)
Female	0.066		0.020	0.385		0.252
	(0.78)		(0.24)	(0.86)		(0.57)
Majority Election	−0.008		−0.016	0.097		0.065
	(−0.33)		(−0.70)	(0.84)		(0.57)
Environmental Rating		0.233***	0.231***		0.313	0.353
		(5.06)	(5.02)		(1.51)	(1.76)
Sustainability Committee		−0.004	−0.004		0.376**	0.354**
		(−0.15)	(−0.14)		(2.77)	(2.61)
Sustainability Report		0.011	0.011		−0.316	−0.272
		(0.58)	(0.55)		(−1.76)	(−1.61)
Stakeholder Engagement		0.033*	0.031		0.240	0.180
		(1.99)	(1.87)		(1.64)	(1.30)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8604	8604	8604	2157	2157	2157
Adjusted R^2	0.239	0.250	0.251	0.260	0.256	0.271

Table 5: Determinants of Internal Carbon Price - Carbon Transition Risks

This table reports OLS regression estimates of two measures of carbon transition risks on ICP adoption and price levels. All coefficients are multiplied by 100 for ease of interpretation. Columns (1) - (3) report results for *ICP Adopter*. Columns (4) - (6) use *ICP Level* as the dependent variable, so coefficients approximate percentage changes in ICP price levels. All variables are winsorized at the 1st and 99th percentiles. All right-hand side variables are lagged by one year. $Country \times Year$ and $Industry \times Year$ fixed effects are included in the models. Standard errors are clustered at the firm and time levels, and t-statistics are reported in parentheses below the estimates. The estimation period is from 2014 to 2021. All the variables are defined in Table A1. ($*$ p < 0.10, $**$ p < 0.05, $***$ p < 0.01)

	ICP Adopter			**ICP Level**		
	(1)	(2)	(3)	(4)	(5)	(6)
SBT	14.462***		13.038***	18.519***		17.475**
	(4.38)		(4.12)	(3.91)		(2.73)
Scope1 Emission		1.855**	1.868**		−3.828	−3.869
		(2.70)	(2.74)		(−1.44)	(−1.43)
Scope2 Emission		0.262	0.323		0.457	0.490
		(0.36)	(0.45)		(0.15)	(0.16)
Board Size	0.035	−0.138	−0.176	−5.332***	−5.200**	−5.234**
	(0.12)	(−0.39)	(−0.51)	(−4.22)	(−3.22)	(−3.31)
Board Independence	0.049	0.029	0.027	0.183	0.247	0.243
	(0.94)	(0.40)	(0.38)	(1.02)	(1.20)	(1.23)
Female	0.001	−0.023	−0.037	0.206	0.217	0.178
	(0.01)	(−0.23)	(−0.37)	(0.46)	(0.42)	(0.35)
Majority Election	−0.014	−0.021	−0.018	0.073	−0.021	−0.015
	(−0.62)	(−0.64)	(−0.58)	(0.66)	(−0.15)	(−0.11)
Environmental Rating	0.206***	0.256***	0.227***	0.314	0.331	0.285
	(4.40)	(4.32)	(3.81)	(1.56)	(1.23)	(1.06)
Sustainability Committee	−0.007	−0.035	−0.037	0.362**	0.335	0.347
	(−0.24)	(−0.89)	(−0.96)	(2.64)	(1.08)	(1.14)
Sustainability Report	0.012	0.018	0.018	−0.263	−0.374	−0.371
	(0.62)	(0.60)	(0.61)	(−1.55)	(−1.72)	(−1.75)
Stakeholder Engagement	0.028	0.007	0.006	0.177	0.296*	0.302
	(1.77)	(0.34)	(0.33)	(1.26)	(1.91)	(1.89)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8604	5312	5312	2157	1466	1466
Adjusted R^2	0.262	0.264	0.274	0.275	0.269	0.272

Table 6: Determinant of Internal Carbon Pricing: National Climate Policy

This table reports the difference-in-difference estimates of quasi-exogenous shocks to ICP adoption and price level set. The dependent variables are *ICP Adopter* and *ICP Level* , respectively. The table shows results for three policies implemented in three jurisdictions: the United States, the United Kingdom, and Canada. Column (1) and (2) focus on the US policy, Columns 3) and (4) focus the UK policy, Columns 5) and (6) focuses on the Canadian policy. All coefficients are multiplied by 100 for interpretability. $Country$ and $Industry \times Year$ fixed effects are included in the models. Standard errors are clustered at the firm and time levels, and t-statistics are reported in parentheses below the estimates.All the variables are defined in Table A1. ($*$ p < 0.10, $**$ p < 0.05, $***$ p < 0.01)

	US announced withdrawal of the Paris Agreement in 2017		**UK legislated a long-term target to reach net-zero by 2050 in 2019**		**Canada's federal output-based pricing system implemented in 2019**	
	ICP Adopter	ICP Level	ICP Adopter	ICP Level	ICP Adopter	ICP Level
	(1)	(2)	(3)	(4)	(5)	(6)
Post*Treatment	−11.780***	−18.049	−6.009	2.758	−8.285	7.100
	(−5.54)	(−0.68)	(−1.37)	(0.13)	(−1.50)	(0.47)
Board Size	0.562	0.756	0.625	−0.891	0.945	−8.815**
	(1.23)	(0.27)	(0.78)	(−0.30)	(0.93)	(−2.38)
Board Independence	0.114*	0.512	0.048	−0.286	0.303**	−1.137**
	(1.66)	(0.61)	(0.45)	(−0.61)	(2.17)	(−2.38)
Female	−0.024	0.915	0.037	0.525	−0.320	−0.503
	(−0.24)	(1.02)	(0.31)	(1.19)	(−1.47)	(−0.91)
Stakeholder Engagement	0.013	0.195	0.016	0.396	−0.044	0.238
	(0.73)	(0.87)	(0.29)	(1.58)	(−0.77)	(1.15)
Majority Election	−0.064*	−0.319*	−0.149***	0.421*	−0.116	−0.141
	(−1.70)	(−1.67)	(−3.04)	(1.66)	(−1.00)	(−0.42)
Environmental Rating	0.199***	0.683	0.332***	0.333	0.192*	1.529***
	(3.41)	(1.53)	(4.02)	(0.79)	(1.78)	(2.69)
Sustainability Committee	−0.014	0.867***	−0.062	0.130	−0.049	0.118
	(−0.49)	(3.18)	(−0.94)	(0.47)	(−0.84)	(0.34)
Sustainability Report	0.004	−0.346	0.053	−0.590***	−0.009	−0.178
	(0.14)	(−0.99)	(0.83)	(−3.91)	(−0.13)	(−1.03)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,392	368	4,456	608	830	236
Adjusted R^2	0.225	0.415	0.272	0.226	0.234	0.309

Table 7: Internal Carbon Price and Firm's Profitability

This table reports estimates from panel regressions. We regress two firm performance variables on our main independent variables: *ICP Adopter* and *ICP Level*, and the following control variables: lagged firm performance, size, and book-to-market ratio. To measure firm performance, we use a firm's Return-on-Asset (%) and Operating Profit Margin (%). In Panel A, we show the results for *ICP Adopter* and Panel B presents the results for *ICP Level*. $Country \times YearQuarter$ and $Indsutry \times YearQuarter$ fixed effects are included in the models. Standard errors are clustered at the firm and time levels, and t-statistics are reported in parentheses below the estimates. The estimation period is from 2014 to 2021. All the variables are defined in Table A1. ($*$ p < 0.10, $**$ p < 0.05, $***$ p < 0.01)

Panel A: ICP Adoption and Firm Profitability

	Return-on-Asset		Operating Profit Margin	
	1Q Ahead	2Q Ahead	1Q Ahead	2Q Ahead
	(1)	(2)	(3)	(4)
ICP Adopter	-0.052***	-0.056***	-0.403***	-0.417**
	(-3.36)	(-3.05)	(-2.80)	(-2.22)
Lagged Dependent Variable	0.695***	0.642***	0.733***	0.692***
	(15.17)	(16.08)	(30.22)	(29.90)
Size	0.033***	0.032**	0.491***	0.512***
	(3.27)	(2.22)	(4.63)	(3.59)
BM Ratio	-0.313***	-0.351***	-1.290***	-1.365***
	(-8.36)	(-7.57)	(-6.72)	(-4.86)
Country-Year Quarter FE	Yes	Yes	Yes	Yes
Industry-Year Quarter FE	Yes	Yes	Yes	Yes
Observations	38927	39304	39572	39518
Adj R-square	0.622	0.562	0.681	0.635

Panel B: ICP Level and Firm Performance

	Return-on-Asset		Operating Profit Margin	
	1Q Ahead	2Q Ahead	1Q Ahead	2Q Ahead
	(1)	(2)	(3)	(4)
ICP Level	-0.001	0.003	0.001	0.005
	(-0.04)	(0.18)	(0.01)	(0.04)
Lagged Dependent Variable	0.692***	0.629***	0.714***	0.671***
	(13.18)	(12.68)	(29.89)	(26.44)
Size	0.047***	0.053**	0.456***	0.461***
	(3.25)	(2.40)	(2.74)	(3.01)
BM Ratio	-0.211***	-0.215***	-1.138***	-0.987***
	(-6.52)	(-5.01)	(-4.99)	(-2.76)
Country-Year Quarter FE	Yes	Yes	Yes	Yes
Industry-Year Quarter FE	Yes	Yes	Yes	Yes
Observations	8199	8286	8347	8330
Adj R-square	0.654	0.582	0.652	0.605

Table 8: Internal Carbon Pricing and Within-Firm Capital Allocation

This table reports estimates from segment-level panel regressions examining how internal carbon pricing (ICP) adoption affects the allocation of capital expenditures across business divisions. The dependent variable is the division's capital-expenditure intensity, measured as capital expenditures divided by segment assets. The main independent variable is segment-level Return-on-Asset (*ROA*) (%) and its interaction with the firm-level indicator of internal carbon price adoption (*ICP Adopter*). The models control for lagged segment capital expenditure, segment size, segment age, firm size, book-to-market ratio, leverage, and cash holdings. In columns (1) to (3), we present the baseline results using *ICP Adopter* as the key variable. We further extend the analysis by interacting *ICP Adopter* and *ROA* with a *Small Board* in columns (4) to (6), a dummy equals one for firms with below-median board size within a given year. Firm and year fixed effects are included in all regressions. The estimation period is 2014-2021. Standard errors are clustered at the firm level, and *t*-statistics are reported in parentheses below the coefficients. All variables are defined in Table A1. ($*$ $p < 0.10$, $**$ $p < 0.05$, $***$ $p < 0.01$)

ICP Adoption and Division-Level Capital Expenditure						
	CapEx (Division)					
	(1)	(2)	(3)	(4)	(5)	(6)
ICP Adopter*ROA Division	-0.019***	-0.019***	-0.023**	-0.005	-0.005	-0.006
	(-3.43)	(-3.35)	(-2.44)	(-0.41)	(-0.39)	(-0.41)
ICP Adopter*ROA Division*Small Board				-0.031**	-0.032**	-0.042***
				(-2.01)	(-2.04)	(-2.69)
ICP Adopter*Small Board				-0.168	-0.163	-0.015
				(-0.39)	(-0.38)	(-0.03)
ROA Division*Small Board				0.012	0.012	0.020
				(0.94)	(0.97)	(1.22)
ICP Adopter	-0.133	-0.166	-0.549	-0.254	-0.287	-0.757
	(-0.40)	(-0.50)	(-1.27)	(-0.52)	(-0.59)	(-1.27)
ROA Division	-0.013	-0.010	-0.009	-0.020	-0.019	-0.019
	(-1.58)	(-1.30)	(-1.08)	(-1.51)	(-1.43)	(-1.30)
Small board				-0.299	-0.306	-0.340
				(-1.25)	(-1.28)	(-1.25)
Lagged Capex	0.517***	0.516***	0.469***	0.516***	0.514***	0.461***
	(8.42)	(8.29)	(6.41)	(7.58)	(7.42)	(5.99)
Division Controls	No	Yes	Yes	No	Yes	Yes
Firm Controls	No	No	Yes	No	No	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5808	5808	4297	4653	4653	3671
Adj R-square	0.541	0.543	0.530	0.547	0.548	0.533

Table 9: Internal Carbon Price and Stock Return

This table reports estimates from panel regressions. We regress a stock's monthly return on our independent variable and the following firm-level controls: the firm size, the book-to-market ratio of a firm one month prior, the dividend yield, cumulative return in the previous months, dollar trading volume, stock price, the standard deviation of the residual from regressing excess returns for the firm between months t-13 and t-2 on the excess stock market return, and the absolute returns over trading volume for the firm between months t-13 and t-2. We also control the following country-level variables: GDP growth, GDP per capita, stock market capitalization over GDP, and inflation rate. Our main independent variables are *ICP Adopter* in Panel A and *ICP Level* in Panel B. We use three different measures on stock return as our dependent variable: *Raw Return* is the return of the stock, the *Industry-adjusted Return* is the stock return minus the industry average return, and the *Market-adjusted Return* is the *Raw Return* minus the market return of the country. Stock returns are winsorized at the 1% level. Country and year-month fixed effects are included in the models. Standard errors are clustered at the firm and time levels, and t-statistics are reported in parentheses below the estimates. The estimation period is from 2014 to 2021. All the variables are defined in Table A1. ($*$ $p < 0.10$, $**$ $p < 0.05$, $***$ $p < 0.01$)

Panel A: Internal Carbon Price Adoption and Stock Return

	Raw Return			Industry Adjusted Return			Market Adjusted Return		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ICP Adopter	-0.125	0.115	0.137	-0.050	0.118	0.135	-0.121	0.094	0.115
	(-1.29)	(1.33)	(1.23)	(-0.61)	(1.43)	(1.21)	(-1.31)	(1.23)	(1.30)
Size		0.012	0.023		0.055	0.064		0.015	0.024
		(0.18)	(0.34)		(0.93)	(1.08)		(0.24)	(0.35)
BM Ratio		-1.066***	-1.137***		-0.856***	-0.905***		-1.010***	-1.065***
		(-5.23)	(-5.55)		(-6.28)	(-6.59)		(-5.18)	(-5.37)
YLD		-0.249***	-0.253***		-0.194***	-0.191***		-0.180***	-0.188***
		(-4.88)	(-3.63)		(-4.66)	(-3.40)		(-4.44)	(-3.17)
Ret2-3		0.020	0.017		0.012	0.010		0.018	0.015
		(1.54)	(1.40)		(1.18)	(1.00)		(1.48)	(1.46)
Ret4-6		0.008	0.007		0.005	0.005		0.002	0.001
		(1.03)	(0.87)		(0.86)	(0.73)		(0.25)	(0.16)
Ret7-12		-0.007	-0.008		-0.007	-0.008		-0.008	-0.010
		(-1.06)	(-1.27)		(-1.33)	(-1.51)		(-1.26)	(-1.51)
Trading Volume		0.001	0.001		0.003	0.003		-0.001	-0.001
		(0.09)	(0.11)		(0.53)	(0.42)		(-0.15)	(-0.11)
Price		-0.005***	-0.005***		-0.004***	-0.005***		-0.004***	-0.005***
		(-4.29)	(-4.37)		(-4.40)	(-4.34)		(-4.82)	(-4.88)
IDIOVOL		0.000	0.000		0.000	0.000		0.000	0.000
		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)	(0.00)
ILLIQ		3061.709*	3767.077**		3848.821**	4576.481**		2660.549	3253.313*
		(1.72)	(2.10)		(2.39)	(2.65)		(1.59)	(1.95)
GDP growth			-0.013			0.009			0.004
			(-0.25)			(0.17)			(0.07)
GDP per capita			0.835			0.998			1.042
			(0.76)			(1.11)			(1.37)
GDP mktcap			-3.220***			-2.925***			-2.431**
			(-3.66)			(-3.55)			(-2.51)
Inflation			-0.031			-0.005			-0.040
			(-0.47)			(-0.08)			(-0.62)
Country Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-month Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	160162	117090	101395	160162	117090	101395	160162	117090	101395
Adj R-square	0.204	0.213	0.218	0.010	0.017	0.021	0.022	0.028	0.030

Table 9-continued: Internal Carbon Price and Stock Return

Panel B: Internal Carbon Price and Stock Return

	Raw Return			Industry Adjusted Return			Market Adjusted Return		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ICP Level	0.008	0.025	0.033	0.021	0.039	0.039	0.010	0.029	0.040
	(0.16)	(0.69)	(0.74)	(0.44)	(1.02)	(0.82)	(0.23)	(0.74)	(0.72)
Size		-0.001	0.026		0.059	0.073		0.026	0.052
		(-0.00)	(0.21)		(0.58)	(0.66)		(0.25)	(0.47)
BM Ratio		-0.721***	-0.812***		-0.548***	-0.605***		-0.694***	-0.774***
		(-3.15)	(-3.90)		(-3.36)	(-4.04)		(-3.36)	(-3.89)
YLD		-0.233***	-0.205**		-0.172***	-0.140*		-0.184***	-0.152*
		(-3.40)	(-2.27)		(-3.04)	(-1.88)		(-3.14)	(-1.76)
Ret2-3		0.030	0.029		0.019	0.020		0.026	0.025
		(1.47)	(1.58)		(1.15)	(1.20)		(1.39)	(1.52)
Ret4-6		0.021*	0.023*		0.019*	0.021*		0.012	0.013
		(1.80)	(1.72)		(1.90)	(1.92)		(1.04)	(1.03)
Ret7-12		-0.006	-0.009		-0.005	-0.007		-0.006	-0.009
		(-0.53)	(-0.73)		(-0.51)	(-0.65)		(-0.58)	(-0.82)
Trading Volume		0.003	-0.000		0.006	0.002		0.001	-0.002
		(0.31)	(-0.01)		(0.71)	(0.16)		(0.10)	(-0.17)
Price		-0.005***	-0.005***		-0.004***	-0.004***		-0.004***	-0.005***
		(-3.19)	(-4.04)		(-3.20)	(-3.77)		(-3.38)	(-4.28)
IDIOVOL		0.000	0.000		0.000	0.000		0.000	0.000
		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)	(0.00)
ILLIQ		1834.036	3109.918		2616.034	3037.114		322.000	1358.650
		(0.72)	(1.14)		(1.15)	(1.21)		(0.13)	(0.53)
GDP growth			-0.057			-0.017			-0.018
			(-0.97)			(-0.28)			(-0.25)
GDP per capita			1.640			1.706			1.242
			(0.64)			(0.74)			(0.67)
GDP mktcap			-2.716***			-2.454**			-2.217*
			(-2.76)			(-2.60)			(-1.70)
Inflation			-0.133			-0.080			-0.116
			(-1.26)			(-0.89)			(-1.32)
Country Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-month Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	35061	25451	21418	35061	25451	21418	35061	25451	21418
Adj R-square	0.243	0.245	0.244	0.019	0.022	0.027	0.032	0.036	0.038

Table 10: Internal Carbon Price and Future Carbon Emission

This table reports estimates from panel regressions. We regress firm's carbon emission on our main independent variable, *ICP Adopter* and *ICP Level*, and the following control variables: lagged firm leverage, capital expenditure, cash, and earning variability. We use all three scopes of carbon emission data derived from CDP data and include the following measures: the emission, the emission changes, and the emission scaled by sales. In Panel A, we show the regression results between the *ICP Adopter* and the carbon emission in the next one and two years. The regression results between the *ICP Level* and the one and two ahead carbon emission are shown in Panel B. Country × Year and Industry × Year fixed effects are included in the models. Standard errors are clustered at the firm and time levels, and *t*-statistics are reported in parentheses below the estimates. The estimation period is from 2014 to 2021. All the variables are defined in Table A1. ($*$ $p < 0.10$, $**$ $p < 0.05$, $***$ $p < 0.01$)

Panel A: Internal Carbon Price Adoption and Future Carbon Emission

	Δ Scope1	Scope1 Intensity	Scope1	Δ Scope1	Scope1 Intensity	Scope1
	One-Year Ahead			Two-Year Ahead		
	(1)	(2)	(3)	(4)	(5)	(6)
ICP Adopter	-0.051*	0.056	0.026	-0.058**	0.078	0.052
	(-2.13)	(1.01)	(0.79)	(-2.66)	(1.74)	(1.76)
Lagged Dependent Variable	-0.018	0.907***	0.964***	-0.046	0.876***	0.938***
	(-0.77)	(41.80)	(114.38)	(-0.85)	(20.17)	(70.53)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3082	3806	4408	2435	2938	3447
Adj R-square	0.000	0.914	0.979	0.019	0.878	0.965

Panel B: Internal Carbon Price Level and Future Carbon Emission

	Δ Scope1	Scope1 Intensity	Scope1	Δ Scope1	Scope1 Intensity	Scope1
	One-Year Ahead			Two-Year Ahead		
	(1)	(2)	(3)	(4)	(5)	(6)
ICP Level	0.007	-0.034***	0.015***	0.003	-0.038	0.026
	(0.97)	(-5.37)	(6.12)	(0.47)	(-1.74)	(1.71)
Lagged Dependent Variable	-0.121	0.938***	0.987***	-0.047	0.939***	0.974***
	(-1.20)	(26.24)	(150.07)	(-1.35)	(29.63)	(87.21)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	718	833	897	507	595	646
Adj R-square	0.031	0.955	0.990	0.220	0.934	0.986

Appendix

Table A1: Variable Definitions

Panel A. Internal Carbon Price Adoption		
Variable	**Definition**	**Source**
ICP Adopter	ICP Adopter is a binary dummy variable where 1 indicates a firm *i* has adopted ICP in year *t*, and 0 denotes non-adoption.	CDP
ICP ($/*tonCO2e*)	ICP ($/ton CO2e) is measured annually for each firm based on the average of various types of ICPs and corresponding prices reported within a specific year, expressed in USD/ton CO2e (Annual)	CDP
ICP Level	ICP Level is the natural logarithm of ICP ($/ton CO2e)	CDP
Shadow Price	Shadow Price is measured based on the prevailing or forecasted price of carbon regulations	CDP
Implicit Price	Implicit Price is an ex-post assessment of an investment decision, such as the implementation of new low carbon technology	CDP
Offsets	Offsets is the price to purchase offset credits externally	CDP
Internal Fee	Internal Fee is a per-unit fee based on the amount of GHG the company emits	CDP
Internal Trading	Internal Trading allows business units within a company to trade their allocated carbon credits based on respective emissions	CDP
Panel B. Firm Level Variables		
Board Size	Total number of board members	Refinitiv
Board Independence (%)	The percentage of independent board members	Refivitiv
Female (%)	Female (%) The percentage of female on the board	Refinitiv
Majority Election (%)	Majority score evaluates the governance practice related to the election of board members within a company, focusing particularly on whether these members are generally elected by a majority vote. This score is part of Refinitiv's ESG - Governance - Shareholders category	Refinitiv

Table A1: Variable Definitions (Continued...)

	Panel B. Firm Level Variables	
Environmental Rating (%)	Environmental Rating measures a company's impact on natural systems, encompassing living and non-living elements like air, land, water, and entire ecosystems. It evaluates how effectively a company employs best management practices to both mitigate environmental risks and seize opportunities related to environmental sustainability (0-100).	Refinitiv
Sustainability Committee (%)	Sustainability Committee score assesses whether a company has a dedicated CSR (Corporate Social Responsibility) committee or team, indicating the seriousness and structural integration of CSR in the company's strategic decision-making processes (0-100).	Refinitiv
Sustainability Report (%)	Sustainability Report score evaluates a company's commitment to transparency in disclosing its environmental, social, and corporate governance (ESG) practices (0-100)	Refinitiv
Stakeholder Engagement (%)	Stakeholder Engagement score quantifies a company's engagement with its stakeholders by evaluating the extent and effectiveness of its interactions. It is derived from Refinitiv's ESG Indicator Score framework (0-100)	Refinitiv
Size	Size of a firm is measured by the log of the firm's market capitalization	Refinitiv
Cash (%)	Cash(%) is measured by the cash and cash equivalents divided by total assets * 100. (Annually)	Refinitiv
Leverage (%)	Leverage (%) is the long-term debt percentage of total assets. (Annually)	Refinitiv
Profitability (%)	Profitability (%) is measured by the net income incl extra before distributions divided by total assets * 100. (Annually)	Refinitiv
Asset Tangibility (%)	Asset Tangibility(%) is the property, plant and equipment divided by total assets * 100. (Annually)	Refinitiv
Market_to_book	Market_to_book ratio is the ratio between Market capitalization and the total book capital. (Annually)	Refinitiv
ROA (%)	Return on Assets is measured by the EBIT margin times the revenue divided by the total assets. (Quarterly)	Refinitiv
OPM (%)	Operating Profit Margin is Refinitiv item EBIT margin. (Quarterly)	Refinitiv
Industry – Adj Return	Industry Adjusted return is measured by the stock return minus the average return of all stocks within the same industry in the same month (Monthly)	Refinitiv & Kenneth's Library
Market – Adj Return	Industry Adjusted Return is measured by the stock return minus the average return of all stocks within the same country in the same month (Monthly)	Refinitiv & Kenneth's Library
BM Ratio	Book-to-Market Ratio is measured by the ratio between the total book capital value and the market capitalization (Quarterly)	Refinitiv
Dividend Yield	Dividend Yield is measured by the total dividends paid cash flow divided by the market Capitalization (Quarterly)	Refinitiv
*Ret*2_3	Cumulative return of a firm over months t-3 through t-2 (Monthly)	Refinitiv
*Ret*4_6	Cumulative return of a firm over months t-6 through t-4 (Monthly)	Refinitiv
*Ret*7_12	Cumulative return of a firm over months t-12 through t-7 (Monthly)	Refinitiv

Table A1: Variable Definitions (Continued...)

Panel B. Firm Level Variables		
Trading Volume	Dollar trading volume of a stock in the previous month (in millions) (Monthly)	Refinitiv
Price	Stock price of a firm at the end of month t-2 (Monthly)	Refinitiv
IDIOVOL	Idiosyncratic volatility Standard deviation of the residual from regression excess returns for a firm between month t-13 and t-2 on the excess stock market return (Monthly)	Refinitiv & Kenneth's Library
ILLIQ	Illiquidity is the absolute returns over trading volume for a firm between month t-13 and t-2 (Monthly)	Refinitiv
Capex (%)	Capital Expenditure is measured by the capital expenditure divided by the firm total asset (Quarterly)	Refinitiv
Capex (Division) (%)	Capital Expenditure (Division) is measured by the division capital expenditure divided by the division asset (Annual)	Compustat Segment
ROA (Division) (%)	Return-on-Asset (Division) is measured by the division operating income after depreciation divided by the division asset (Annual)	Compustat Segment
OPM (Division) (%)	Operating Profit Margin (Division) is measured by the division operating income after depreciation divided by the division revenue (Annual)	Compustat Segment
Size (Division)	Size (Division) is measured by the log of the division asset (Annual)	Compustat Segment
Division Age	Division Age is measured by the year difference between the current year at the year when the division is first time listed in the dataset (Annual)	Compustat Segment
Panel C. Country Level Variables		
GDP growth	GDP_growth is the percentage change of GDP for a specific country from year t-1 to year t (Annual)	World Bank
GDP per capita	GDP per capita is by GDP divided by mid-year population of a country (Annual)	World Bank
GDP mktcap	GDP_mktcap is measured by GDP divided by the total market capitalization of a country (Annual)	World Bank
Inflation	Inflation is measured by the percentage change of CPI of a country (Annual)	World Bank
Panel D. Carbon Transition Risk		
SBT	Science-based target dummy. A dummy variable equals to 1 if a firm adpots the science-based target and 0 otherwise. (Annually)	CDP
*Scope*1 *Emission*	Log (Carbon emissions scope 1 (tons CO2e))	CDP & Refinitiv
*Scaled Scope*1 *Emission*	Scope 1 divided by the total revenue of the firm (Annual)	CDP & Refinitiv
*Scope*2 *Emission*	Log (Carbon emissions scope 2 (tons CO2e))	CDP & Refinitiv
Δ*Scope*1 *Emission* (%)	Growth Rate in Carbon Emissions Scope 1 / Changes in Scope 1 Emission (winsorized at 1%) (Annual)	CDP & Refinitiv

Table A2: Internal Carbon Prices by Country, Industry, and Year

Panel A: Summary Statistics by Country

Jurisdiction	N (Firm)	N (Adoptors)	N (Obs)	Mean	St.dev	Q1	Median	Q3
USA	501	95	2228	32.561	40.202	10.000	20.000	40.000
Japan	275	106	1276	99.395	173.048	15.927	38.267	91.735
United Kingdom	154	53	696	41.819	33.533	22.905	27.508	50.000
Canada	98	35	415	37.640	38.138	22.369	25.598	37.281
France	81	40	399	60.876	58.424	34.266	50.225	70.628
Germany	71	32	335	85.197	113.215	27.987	43.975	100.801
Republic of Korea	64	48	298	28.907	18.575	19.607	24.885	31.335
Taiwan,China	59	28	236	48.049	45.887	26.298	49.782	50.946
Sweden	56	13	220	74.360	103.429	15.987	34.512	105.383
Brazil	51	21	182	18.432	34.492	1.900	7.417	12.534
Australia	51	12	180	30.631	28.529	9.810	12.066	45.527
Switzerland	47	20	211	46.051	38.981	10.000	31.954	97.047
China	42	2	72	10.580	8.559	7.554	10.580	13.606
India	39	16	140	16.953	20.073	10.000	11.538	15.388
South Africa	36	15	121	7.669	2.716	6.480	8.305	9.068
Spain	34	19	166	36.022	24.174	17.666	33.510	47.316
Italy	33	15	123	33.690	25.943	12.873	27.897	53.272
Finland	32	14	159	47.298	31.294	27.516	33.584	65.041
Netherlands	29	14	127	61.957	38.938	40.496	57.110	62.892
Norway	26	10	113	101.708	83.664	50.000	61.467	145.707
Republic of Ireland	22	10	103	42.796	28.520	28.000	33.584	59.145
Denmark	19	6	93	58.053	41.839	29.861	38.214	99.251
Hong Kong SAR.China	19	3	79	28.963	55.289	2.499	2.578	10.009

Table A2: Internal Carbon Prices by Country, Industry, and Year (Continued...)

Jurisdiction	N (Firm)	N (Adoptors)	N (Obs)	Mean	St.dev	Q1	Median	Q3
Russia	17	6	55	35.901	31.182	2.100	40.834	58.125
New Zealand	16	10	68	28.675	30.810	16.470	19.106	23.059
Belgium	16	4	69	80.178	19.045	63.649	83.865	85.687
Singapore	16	2	57	4.947	7.549	0.055	0.103	10.902
Thailand	13	8	50	20.199	11.042	15.000	19.169	20.812
Austria	12	9	57	32.740	25.437	16.907	28.271	51.776
Portugal	10	8	43	33.050	23.400	12.623	31.886	41.326
Mexico	10	6	39	42.564	31.543	30.000	30.000	32.870
Philippines	8	3	18	8.353	8.188	5.038	5.057	5.076
Chile	7	5	31	12.027	18.977	1.000	5.000	7.500
Luxembourg	5	3	17	50.573	30.538	28.644	41.792	66.249
Turkey	4	1	12	1.000	0.000	1.000	1.000	1.000
Israel	3	1	10	44.000	22.627	36.000	44.000	52.000
Cayman Islands	2	1	9	3.933	1.059	3.477	3.493	3.592
Hungary	2	1	10	1.386	0.081	1.320	1.376	1.458
Saudi Arabia	2	1	5	10.933	5.867	8.000	8.000	10.933
Czech Republic	1	1	4	2.112	1.227	1.199	1.745	2.658
Kuwait	1	1	3	91.750		91.750	91.750	91.750

Table A2: Internal Carbon Prices by Country, Industry, and Year (Continued...)

Panel B: Summary Statistics by ICB Industry								
ICB Industry	N (Firm)	N (Adoptors)	N (Obs)	Mean	St.dev	Q1	Median	Q3
Industrials	500	147	2120	56.265	80.883	17.797	33.547	60.101
Consumer Discretionary	343	94	1400	75.750	130.468	15.074	27.888	69.505
Basic Materials	216	115	901	40.623	31.547	18.223	30.000	57.110
Technology	212	62	863	35.742	46.177	10.000	20.000	48.564
Consumer Staples	179	62	828	38.166	34.371	11.239	30.000	55.974
Utilities	130	80	635	31.943	35.634	12.647	22.611	37.298
Health Care	125	27	575	116.555	218.642	25.460	59.048	100.000
Energy	113	58	473	39.434	32.921	22.369	32.744	49.230
Telecommunications	92	30	404	34.189	32.870	12.950	22.561	50.404
Real Estate	81	19	312	45.979	57.313	9.027	24.865	52.607
Financials	33	4	93	29.461	14.202	16.987	27.092	37.413

Panel C: Summary Statistics by Year

Year	N (Firm)	N (Adoptors)	N (Obs)	Mean	St.dev	Q1	Median	Q3
2014	601	53	601	31.257	29.573	12.350	25.090	35.000
2015	829	86	829	43.055	102.471	8.928	24.055	36.636
2016	889	106	889	40.830	94.002	13.935	23.826	38.586
2017	879	211	879	35.497	57.909	9.245	19.462	39.031
2018	1022	286	1022	45.784	88.661	11.720	24.774	46.201
2019	1222	384	1222	46.159	80.146	15.074	27.841	48.564
2020	1497	477	1497	51.593	88.552	16.930	30.000	56.193
2021	1665	585	1665	60.382	77.195	19.733	41.402	75.000

Table A3: Determinants of Internal Carbon Price Adoption and Price (including or excluding offsets)

This Table presents robustness checks for the OLS regression estimates from Table 4. Columns (1), (3), and (5) in Panel A replicate the results from Table 4 (columns 1, 2, and 3, respectively), while columns (2), (4), and (6) in Panel A exclude the offsets-type *ICP Adopter* to assess the robustness of the findings; W/O in the table means data without Offset type. Specifically, columns (1) and (2) do not control for fixed effects, columns (3) and (4) represent the baseline model, and columns (5) and (6) include firm fixed effects and year fixed effects. Columns (1), (3), and (5) of Panel B replicate the results from Table 4 (columns (4), (5), and (6), respectively), while columns (2), (4), and (6) exclude the offsets-type *ICP Level* to assess the robustness of the findings. All coefficients are multiplied by 100 for ease of interpretation. Country × year and Industry × year fixed effects are included in the models. Standard errors are clustered at the firm and time levels and *t*-statistics are reported in parentheses below the estimates. The estimation period is from 2014 to 2021. All the variables are defined in Table A1. ($*$ $p < 0.10$, $**$ $p < 0.05$, $***$ $p < 0.01$)

Panel A: Determinants of ICP Adopter

	Adopter	Adopter-W/O Offset	Adopter	Adopter-W/O Offset	Adopter	Adopter-W/O Offset
	(1)	(2)	(3)	(4)	(5)	(6)
Board Size	0.247	0.274			0.054	0.082
	(0.79)	(0.93)			(0.18)	(0.29)
Board Independence	0.078	0.082			0.056	0.059
	(1.52)	(1.75)			(1.06)	(1.25)
Female	0.066	0.069			0.020	0.023
	(0.78)	(0.84)			(0.24)	(0.29)
Majority Election	−0.008	−0.012			−0.016	−0.020
	(−0.33)	(−0.52)			(−0.70)	(−0.89)
Environmental Rating			0.233***	0.234***	0.231***	0.232***
			(5.06)	(5.22)	(5.02)	(5.17)
Sustainability Committee			−0.004	−0.006	−0.004	−0.006
			(−0.15)	(−0.21)	(−0.14)	(−0.19)
Sustainability Report			0.011	0.007	0.011	0.007
			(0.58)	(0.39)	(0.55)	(0.35)
Stakeholder Engagement			0.033*	0.034*	0.031	0.032*
			(1.99)	(2.06)	(1.87)	(1.95)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8604	8604	8604	8604	8604	8604
Adjusted R^2	0.239	0.245	0.250	0.256	0.251	0.256

Table A3: Determinants of Internal Carbon Price Adoption and Price (including or excluding offsets) (Continued...)

	Panel B: Determinants of ICP Level					
	ICP Level	ICP Level-W/O Offset	ICP Level	ICP Level-W/O Offset	ICP Level	ICP Level-W/O Offset
	(1)	(2)	(3)	(4)	(5)	(6)
Board Size	−5.444***	−5.424***			−5.359***	−5.348***
	(−4.00)	(−3.98)			(−4.16)	(−4.14)
Board Independence	0.234	0.313			0.192	0.273
	(1.23)	(1.64)			(1.05)	(1.48)
Female	0.385	0.434			0.252	0.289
	(0.86)	(0.99)			(0.57)	(0.65)
Majority Election	0.097	0.095			0.065	0.058
	(0.84)	(0.81)			(0.57)	(0.51)
Environmental Rating			0.313	0.324	0.353	0.363
			(1.51)	(1.53)	(1.76)	(1.76)
Sustainability Committee			0.376**	0.362**	0.354**	0.336**
			(2.77)	(2.75)	(2.61)	(2.58)
Sustainability Report			−0.316	−0.314	−0.272	−0.270
			(−1.76)	(−1.78)	(−1.61)	(−1.63)
Stakeholder Engagement			0.240	0.260	0.180	0.196
			(1.64)	(1.78)	(1.30)	(1.43)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,157	2,117	2,157	2,117	2,157	2,117
Adjusted R^2	0.260	0.261	0.256	0.255	0.271	0.272

Table A4: Determinants of Internal Carbon Price Adoption and Price by Type

This table reports OLS regression estimates of board and stakeholder governance variables on *ICP Adopter* and *ICP* by type. We report the results for *ICP Adopter* and *ICP Level* in Panel A and Panel B, repectively. All coefficients are multiplied by 100 for ease of interpretation and reflect percentage point changes in the probability of *ICP Adopter* for a specific ICP type (in Panel A), or percentage point changes in *ICP Level* (in Panel B), associated with a one-unit change in the explanatory variable. "Other" in column (6) refers to instances in CDP reports where companies indicated using an ICP and reported a price but did not specify the type. Country × year and Industry × year fixed effects are included in the models. Standard errors are clustered at the firm and time levels, and *t*-statistics are reported in parentheses below the estimates. The estimation period is from 2014 to 2021. All the variables are defined in Table A1. ($*$ $p < 0.10$, $**$ $p < 0.05$, $***$ $p < 0.01$)

Panel A: Determinants of ICP Adopter by Type

	Shadow Price (1)	Implicit Price (2)	Offsets (3)	Internal Fee (4)	Internal Trading (5)	Other (6)
Board Size	0.062	−0.136	0.038	0.324*	−0.011	0.028
	(0.24)	(−0.90)	(0.43)	(1.92)	(−0.29)	(0.32)
Board Independence	0.044	−0.006	−0.002	0.047*	0.002	−0.004
	(0.99)	(−0.18)	(−0.11)	(1.94)	(0.25)	(−0.30)
Female	−0.003	0.050	0.029	−0.079*	−0.009	0.001
	(−0.05)	(1.00)	(1.10)	(−2.20)	(−0.99)	(0.08)
Majority Election	0.012	0.005	−0.006	−0.006	−0.001	−0.005
	(0.58)	(0.45)	(−0.78)	(−0.51)	(−0.14)	(−0.86)
Environmental Rating	0.165***	0.043	0.002	0.066**	0.003	0.006
	(5.08)	(1.73)	(0.19)	(3.26)	(0.35)	(0.51)
Sustainability Committee	0.008	−0.036	−0.013	0.010	−0.006	0.005
	(0.51)	(−1.80)	(−1.34)	(1.13)	(−1.24)	(0.86)
Sustainability Report	−0.002	0.008	0.011	0.002	−0.003	−0.011
	(−0.09)	(0.70)	(1.60)	(0.20)	(−0.82)	(−1.23)
Stakeholder Engagement	0.023	0.015	0.013*	−0.006	−0.004	0.001
	(1.73)	(1.20)	(2.02)	(−1.04)	(−1.26)	(0.25)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8604	8604	8604	8604	8604	8604
Adjusted R^2	0.184	0.044	0.032	0.095	0.028	0.038

Table A4: Determinants of Internal Carbon Price Adoption and Price by Type (Continued...)

Panel B: Determinants of ICP by Type						
	Shadow Price	Implicit Price	Offsets	Internal Fee	Internal Trading	Other
	(1)	(2)	(3)	(4)	(5)	(6)
Board Size	−3.594***	−12.427	4.543	−6.829	−15.346	22.969
	(−2.65)	(−1.61)	(0.18)	(−1.11)	(−1.35)	(0.77)
Board Independence	0.283	0.145	−6.798	0.237	−0.758	2.404
	(1.30)	(0.22)	(−1.28)	(0.14)	(−0.39)	(0.28)
Female	0.075	−0.632	−2.010	0.167	−4.196	−1.786
	(0.18)	(−0.41)	(−0.36)	(0.14)	(−0.88)	(−0.45)
Majority Election	−0.062	0.332	0.871	−1.113***	−2.291*	2.519
	(−0.38)	(0.74)	(0.40)	(−2.70)	(−1.73)	(0.54)
Environmental Rating	0.010	1.032*	1.721	0.809	−2.877*	6.800*
	(0.04)	(1.91)	(0.35)	(0.98)	(−1.93)	(1.84)
Sustainability Committee	0.470**	0.210	0.346	−0.261	1.163*	−1.767
	(2.16)	(0.30)	(0.27)	(−0.35)	(1.77)	(−0.89)
Sustainability Report	−0.280*	0.651*	1.692	−0.712	−1.719	−5.389
	(−1.67)	(1.67)	(0.43)	(−1.27)	(−0.71)	(−1.49)
Stakeholder Engagement	0.252*	−1.127***	−0.853	0.192	−2.919	0.182
	(1.70)	(−2.80)	(−0.34)	(0.30)	(−0.89)	(0.07)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	No	Yes
Industry-YearFE	Yes	Yes	Yes	Yes	No	Yes
Observations	1527	403	158	346	40	127
Adjusted R^2	0.298	0.157	0.127	0.252	0.210	0.886

Table A5: Determinants of Internal Carbon Price by Country

This table reports OLS regression estimates of firm-level board and stakeholder governance variables on *ICP Level* by country. The 12 countries listed are those with the largest number of firms adopting ICP in the sample. All coefficients are multiplied by 100 for ease of interpretation. Coefficients therefore represent approximate percentage changes in *ICP Level* associated with a one-unit change in each explanatory variable. All variables are winsorized at the 1st and 99th percentiles. All right-hand side variables are lagged by one year. Country × year and Industry × year fixed effects are included in the models. Standard errors are clustered at the firm and time levels and *t*-statistics are reported in parentheses below the estimates. The estimation period is from 2014 to 2021. All the variables are defined in Table A1. ($*$ $p < 0.10$, $**$ $p < 0.05$, $***$ $p < 0.01$)

	ICP Level by Country					
	USA	Japan	United Kingdom	France	Republic of Korea	Canada
	(1)	(2)	(3)	(4)	(5)	(6)
Board Size	−0.366	−12.995**	−4.260	−2.347	−0.608	−12.035**
	(−0.08)	(−3.09)	(−0.72)	(−0.49)	(−0.34)	(−3.50)
Board Independence	0.731	−0.617	−0.969	−0.725	0.633	−1.299
	(0.53)	(−0.80)	(−1.51)	(−1.40)	(1.72)	(−1.61)
Female	0.391	0.191	1.615**	−1.248	0.099	0.155
	(0.52)	(0.13)	(2.38)	(−0.88)	(0.13)	(0.28)
Majority Election	−0.551	0.230	0.835	−0.162	−0.133	−0.065
	(−1.55)	(0.71)	(1.40)	(−0.46)	(−1.26)	(−0.13)
Environmental Rating	0.966	0.949	0.075	1.244	−0.807*	1.495**
	(1.64)	(1.55)	(0.12)	(1.26)	(−2.33)	(2.93)
Sustainability Committee	0.867**	0.631	0.130	1.330	0.391**	−0.015
	(2.67)	(1.05)	(0.35)	(1.45)	(2.56)	(−0.04)
Sustainability Report	−0.243	−0.291	−0.724	−0.285	0.073	−0.364*
	(−0.50)	(−1.06)	(−1.10)	(−0.69)	(0.34)	(−2.22)
Stakeholder Engagement	0.306	−0.694*	0.161	0.120	0.313	0.367
	(0.84)	(−2.03)	(1.06)	(0.26)	(0.59)	(1.69)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	No	No	No	No	No	No
Industry-Year FE	No	No	No	No	No	No
Observations	300	298	184	154	141	118
Adjusted R^2	0.206	0.274	0.082	0.202	0.236	0.335

Table A5: Determinants of Internal Carbon Price by Country (Continued...)

	Germany	Taiwan	Spain	Switzerland	Italy	Netherlands
Board Size	−1.654	−0.968	8.852	−11.677*	−9.484**	10.063
	(−0.42)	(−0.10)	(1.20)	(−2.04)	(−2.48)	(1.27)
Board Independence	0.846	−1.144	−3.483**	−0.576	1.336***	−1.102
	(1.54)	(−0.34)	(−2.70)	(−0.74)	(3.68)	(−0.68)
Female	1.173	−0.341	5.064	3.199*	−0.572	−4.035*
	(0.68)	(−0.15)	(1.83)	(2.13)	(−1.14)	(−2.26)
Majority Election	0.397	−0.522	0.072	−2.458***	−0.180	0.395
	(0.82)	(−1.18)	(0.17)	(−5.58)	(−0.41)	(0.27)
Environmental Rating	0.745*	2.801	3.567**	0.144	−0.084	3.233
	(2.33)	(1.80)	(2.76)	(0.10)	(−0.05)	(1.51)
Sustainability Committee	1.195***	18.025	0.043	1.615	−18.845*	26.732*
	(4.47)	(1.39)	(0.05)	(1.49)	(−2.18)	(2.57)
Sustainability Report	1.029	−1.554**	1.094**	13.706	−0.908*	0.799
	(1.37)	(−3.19)	(2.76)	(1.07)	(−1.93)	(0.33)
Stakeholder Engagement	0.019	−19.959	−1.117	−2.362*	0.005	−30.724*
	(0.06)	(−1.43)	(−0.99)	(−2.13)	(0.00)	(−2.47)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	No	No	No	No	No	No
Industry-Year FE	No	No	No	No	No	No
Observations	107	73	73	63	60	38
Adjusted R^2	0.138	0.150	0.158	0.488	0.411	0.221

Table A6: Determinants of Internal Carbon Price Adoption and Price by Type - Carbon Transition Risks

This table reports OLS regression estimates of carbon transition risks on *ICP Adopter* and *ICP Level* by type. Panel A reports the results using ICP type-specific adoption dummies as the dependent variable. All coefficients are multiplied by 100 for interpretability. Country × year and Industry × year fixed effects are included in the models. Standard errors are clustered at the firm and time levels and t-statistics are reported in parentheses below the estimates. The estimation period is from 2014 to 2021. All the variables are defined in Table A1. ($*$ $p < 0.10$, $**$ $p < 0.05$, $***$ $p < 0.01$)

Panel A: ICP Adopter by Type

	Shadow Price		Implicit Price		Offsets		Internal Fee		Internal Trading	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SBT	11.102***		3.926***		0.998		1.475		0.962	
	(3.91)		(3.85)		(1.19)		(1.82)		(1.86)	
Scope 1 Emission		1.574**		0.426		0.441		-0.140		0.106
		(2.64)		(1.42)		(1.47)		(-0.39)		(1.81)
Scope 2 Emission		0.159		0.615		-0.335		-0.394		0.076
		(0.25)		(1.82)		(-1.03)		(-1.03)		(1.12)
S1C		-0.174		-0.084		-0.146		-0.086*		-0.001
		(-0.96)		(-1.10)		(-1.74)		(-1.92)		(-0.18)
Board Gov	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Stake Gov	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8604	5312	8604	5312	8604	5312	8604	5312	8604	5312
Adjusted R^2	0.251	0.266	0.126	0.160	0.075	0.101	0.170	0.164	0.107	0.085

Panel B: ICP level by type

	Shadow Price		Implicit Price		Offsets		Internal Fee		Internal Trading	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
SBT	10.598		50.328**		78.949		46.646**		-21.521	
	(1.08)		(2.39)		(1.81)		(2.37)		(-0.26)	
Scope 1 Emission		-3.835		-3.004		35.216*		3.266		-92.039
		(-1.41)		(-0.56)		(2.36)		(0.18)		(-0.13)
Scope 2 Emission		-0.947		-37.871***		-20.771		-0.604		-46.313
		(-0.27)		(-5.80)		(-1.59)		(-0.05)		(-0.05)
S1C		0.813		-0.842		16.058**		2.777		157.099
		(0.74)		(-0.18)		(2.76)		(0.70)		(0.22)
Board Gov	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Stake Gov	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Industry-Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Observations	1527	1076	403	253	158	113	346	207	40	21
Adjusted R^2	0.294	0.353	0.114	0.070	0.137	0.359	0.266	0.300	0.179	0.552

Table A7: Internal Carbon Price and Firm's Profitability: Economic Development

This table reports estimates from panel regressions in two subsamples: developed economies and developing economies. Following the World Bank Income Group classification, we construct our developed economies subgroup using those economies with high income and put other economies in the developing country group. We regress two firm performance variables on our main independent variable, and the following control variables: lagged firm performance, size, and book-to-market ratio. To measure firm performance, we use a firm's ROA and net profit margin. Our main independent variables are *ICP Adopter* and *ICP Level*. We report the results for *ICP Adopter* for developed and developing economies in Panel A and B. Results for *ICP Level* for both types of economies are presented in Panel C and Panel D. Country × year-quarter and Industry × year-quarter fixed effects are included in the models. Standard errors are clustered at the firm and time levels and *t*-statistics are reported in parentheses below the estimates. The estimation period is from 2014 to 2021. All the variables are defined in Table A1. ($*$ $p < 0.10$, $**$ $p < 0.05$, $***$ $p < 0.01$)

Panel A: ICP Adopter and Firm Profitability for Developed Economies

	ROA		Net Profit Margin	
	1Q Ahead	2Q Ahead	1Q Ahead	2Q Ahead
	(1)	(2)	(3)	(4)
ICP Adopter	-0.041***	-0.039**	-0.334**	-0.325*
	(-2.98)	(-2.60)	(-2.46)	(-1.77)
Lagged Dependent Variable	0.694***	0.640***	0.734***	0.693***
	(13.30)	(14.16)	(26.91)	(27.82)
Controls	Yes	Yes	Yes	Yes
Country-Year Quarter FE	Yes	Yes	Yes	Yes
Industry-Year Quarter FE	Yes	Yes	Yes	Yes
Observations	32707	32682	32907	32876
Adj R-square	0.619	0.559	0.685	0.639

Panel B: ICP Adoption and Firm Profitability for Developing Economies

	ROA		Net Profit Margin	
	1Q Ahead	2Q Ahead	1Q Ahead	2Q Ahead
	(1)	(2)	(3)	(4)
ICP Adopter	-0.104***	-0.134***	-0.703***	-0.757**
	(-4.27)	(-3.86)	(-3.44)	(-2.70)
Lagged Dependent Variable	0.679***	0.630***	0.723***	0.683***
	(8.44)	(8.86)	(16.65)	(15.76)
Controls	Yes	Yes	Yes	Yes
Country-Year Quarter FE	Yes	Yes	Yes	Yes
Industry-Year Quarter FE	Yes	Yes	Yes	Yes
Observations	6216	6620	6663	6640
Adj R-square	0.640	0.582	0.662	0.614

Table A7: ICP and Firm's Profitability: Economic Development (Continued...)

Panel C: Internal Carbon Price and Firm Performance for Developed Economies

	ROA		Net Profit Margin	
	1Q Ahead	2Q Ahead	1Q Ahead	2Q Ahead
	(1)	(2)	(3)	(4)
ICP Level	0.003	0.008	0.014	-0.002
	(0.16)	(0.61)	(0.09)	(-0.01)
Lagged Dependent Variable	0.707***	0.642***	0.730***	0.685***
	(12.41)	(12.17)	(32.93)	(29.06)
Controls	Yes	Yes	Yes	Yes
Country-Year Quarter FE	Yes	Yes	Yes	Yes
Industry-Year Quarter FE	Yes	Yes	Yes	Yes
Observations	6704	6714	6762	6755
Adj R-square	0.649	0.579	0.670	0.626

Panel D: Internal Carbon Price and Firm Performance for Developing Economies

	ROA		Net Profit Margin	
	1Q Ahead	2Q Ahead	1Q Ahead	2Q Ahead
	(1)	(2)	(3)	(4)
ICP Level	-0.025	-0.039	-0.114	-0.090
	(-0.39)	(-0.48)	(-0.68)	(-0.25)
Lagged Dependent Variable	0.597***	0.537***	0.646***	0.610***
	(5.52)	(6.02)	(11.15)	(8.13)
Controls	Yes	Yes	Yes	Yes
Country-Year Quarter FE	Yes	Yes	Yes	Yes
Industry-Year Quarter FE	Yes	Yes	Yes	Yes
Observations	1445	1522	1534	1524
Adj R-square	0.657	0.587	0.557	0.497

Table A8: Internal Carbon Price and Stock Return: Economic Development

This table reports estimates from panel regressions for two subsamples: developed and developing economies. Subsamples are divided following the World Bank Income Classifications. Specifically, high-income economies are defined as developed economies and others are developing economies. All the specifications are the same as Table 3 and Table 4. In Panel A and Panel B, we report the results of *ICP Adopter* for developed and developing economies developed economies. Results of *ICP Level* for both types of economies are presented in Panel C and Panel D. Country and year-month fixed effects are included in the models. The estimation period is from 2014 to 2021. Standard errors are clustered at the firm and time levels and *t*-statistics are reported in parentheses below the estimates. All the variables are defined in Table A1. ($*$ $p < 0.10$, $**$ $p < 0.05$, $***$ $p < 0.01$)

Panel A: Internal Carbon Price Adoption and Stock Return for Developed Economies

	Raw Return			Industry Adjusted Return			Market Adjusted Return		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ICP Adopter	-0.153	0.132	0.127	-0.072	0.135	0.135	-0.145	0.112	0.111
	(-1.33)	(1.29)	(1.09)	(-0.68)	(1.32)	(1.19)	(-1.31)	(1.23)	(1.12)
Firm Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Country Controls	No	No	Yes	No	No	Yes	No	No	Yes
Country Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-month Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	133389	97386	87759	133389	97386	87759	133389	97386	87759
Adj R-square	0.230	0.238	0.239	0.014	0.022	0.026	0.027	0.033	0.036

Panel B: Internal Carbon Price Adoption and Stock Return for Developing Economies

	Raw Return			Industry Adjusted Return			Market Adjusted Return		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ICP Adopter	-0.018	0.072	0.193	0.033	0.058	0.094	-0.041	0.035	0.148
	(-0.12)	(0.42)	(0.90)	(0.31)	(0.40)	(0.39)	(-0.35)	(0.23)	(0.73)
Firm Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Country Controls	No	No	Yes	No	No	Yes	No	No	Yes
Country Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-month Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	26773	19704	13636	26773	19704	13636	26773	19704	13636
Adj R-square	0.158	0.172	0.189	0.059	0.063	0.081	0.038	0.050	0.059

Table A8-continued: Internal Carbon Price and Stock Return: Economic Development

Panel C: Internal Carbon Price Level and Stock Return for Developed Economies

	Raw Return			Industry Adjusted Return			Market Adjusted Return		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ICP Level	0.038	0.037	0.049	0.045	0.049	0.062	0.040	0.042	0.059
	(0.96)	(0.80)	(0.83)	(1.06)	(1.13)	(1.16)	(0.99)	(0.86)	(0.96)
Firm Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Country Controls	No	No	Yes	No	No	Yes	No	No	Yes
Country Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-month Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	28582	20491	17835	28582	20491	17835	28582	20491	17835
Adj R-square	0.271	0.274	0.270	0.025	0.032	0.038	0.039	0.047	0.050

Panel D: Internal Carbon Price Level and Stock Return for Developing Economies

	Raw Return			Industry Adjusted Return			Market Adjusted Return		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ICP Level	-0.160	-0.062	-0.018	-0.111	-0.033	-0.051	-0.143	-0.057	-0.020
	(-1.18)	(-0.93)	(-0.07)	(-0.71)	(-0.35)	(-0.22)	(-1.13)	(-0.87)	(-0.07)
Firm Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Country Controls	No	No	Yes	No	No	Yes	No	No	Yes
Country Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-month Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6479	4960	3583	6479	4960	3583	6479	4960	3583
Adj R-square	0.216	0.218	0.231	0.081	0.075	0.093	0.064	0.066	0.078

Table A9: Internal Carbon Price and Capital Expenditure

This table reports estimates from panel regressions. We regress firm's capital expenditure scaled by total asset on our main independent variable, *ICP Adopter* and *ICP Level*, and the following control variables: lagged firm size, lagged firm book-to-market ratio, lagged firm leverage and lagged cash. Country × year-quarter and Industry × year-quarter fixed effects are included in the models. Standard errors are clustered at the firm and time levels and *t*-statistics are reported in parentheses below the estimates. The estimation period is from 2014 to 2021. All the variables are defined in Table A1. ($*$ $p < 0.10$, $**$ $p < 0.05$, $***$ $p < 0.01$)

	Capital Expenditure			
	(1)	(2)	(3)	(4)
ICP Adopter	0.031	0.019		
	(0.61)	(0.38)		
ICP Level			0.020	0.017
			(0.68)	(0.64)
Controls	No	Yes	No	Yes
Country-Time FE	Yes	Yes	Yes	Yes
Industry-Time FE	Yes	Yes	Yes	Yes
Observations	33712	29355	7152	6625
Adj R-square	0.210	0.222	0.276	0.288