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Turning Carbon Into Cash? Cross-Country Evidence on the Profitability of Emission Reductions

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ABSTRACT

Does corporate CO_2 abatement pay? We assembled an international panel of listed firms (2019–2023), linking Scope 1–2 emissions to institutional (G7, CCPI) and search-based attention measures. The dataset consists of an unbalanced panel of 1724 multinational firms, together with a sub-sample of 922 firms operating in G7 economies. Firm and time fixed effects, dynamic system-GMM, and Granger tests indicate that reductions in operational CO_2 are followed by higher returns on assets, with larger effects in G7 markets. National climate ambition (CCPI) does not reliably amplify profitability. By contrast, the information environment moderates payoffs: in G7 economies, ecological-risk attention amplifies the abatement–performance relationship, whereas climate-crisis attention weakens it, despite a modestly positive main effect. Results are robust with alternative abatement measures, though a binary specification produces weaker results outside the G7. The sum of the evidence indicates that decarbonisation is a value-creating capability whose payoff is mediated by attention rather than headline policy. Implications for managers, lenders, investors and regulators follow: credibility, disclosure quality and enforcement shape returns on cuts CO_2.

1 | Introduction

The world emitted an estimated 37.4 gigatonnes of CO_2 in 2024 (Global Carbon Project 2024), with publicly listed companies accounting for nearly two-fifths of this total (CDP 2023). As carbon prices in the EU Emissions Trading System averaged €65 per tonne in 2024 (European Commission 2025) and mandatory climate-risk-disclosure rules were introduced by both the U.S. Securities and Exchange Commission (2024) and the International Sustainabilty Standards Board (2023), firms are facing intensifying regulatory and financial pressures to decarbonise. The strategic relevance of emissions reduction for corporate performance has been further underscored by the implementation of the EU Carbon Border Adjustment Mechanism (European Commission 2023). These developments raise a central question as regards sustainable finance: whether cutting corporate CO_2 emissions enhances firm profitability.

Two research streams in finance are aimed at addressing this question. The first tests whether operating performance improves when firms abate pollution. In this regard, Ibishova et al. (2024) found that a one-percentage-point reduction in emissions increases ROA by around five basis points, and a meta-analysis of 180 estimates (Khamis et al. 2025) likewise concluded that sustainability practices have a positive overall effect on both accounting and market performance.

The second stream examines capital-market pricing. Equity investors require a carbon premium (Bolton and Kacperczyk 2021), with banks charging higher loan spreads to heavy emitters but rewarding credible abatement (Altavilla et al. 2024), and corporate-bond markets similarly price transition risk (Broeders et al. 2024). These patterns are consistent with the resource-based view (RBV) and the Porter hypothesis, which argue that environmental innovation can generate competitive advantages.

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In this context, the present study pursues two main objectives: (i) to assess whether annual reductions in corporate CO_2 emissions lead to subsequent improvements in firm profitability (ROA), and (ii) to examine how this relationship may be conditioned by the institutional context—focusing in particular on membership of G7 economies, the degree of national climate ambition, and stakeholder attention to climate change. The focus on G7 economies is justified by their structural influence within the global economic system, their consolidated regulatory capacity, and their prominent role in climate governance (Liu et al. 2023). These economies, which have historically tended to align their economic policies (Herman et al. 2023), account for approximately 30.7% of global GDP (Rajendran et al. 2023), with some estimates placing their share as high as 40%–45% (Zhang et al. 2024; Rajendran et al. 2023). Their influence extends beyond economics. In fact, G7 countries are responsible for about one-quarter of global CO_2 emissions and nearly 30% of total energy demand (International Energy Agency 2022; Rajendran et al. 2023), and have committed to ambitious decarbonisation targets, including phasing out unabated coal power by 2035 (United Nations 2025).

The G7's combined economic and environmental weight makes it a key setting for analysing the energy transition. The institutional maturity of G7 economies—characterised by robust financial systems, globalisation levels about 35% above the world average (Liu et al. 2023), and advanced compliance and green-finance infrastructures (Altavilla et al. 2024)—enhances the effectiveness of environmental policy. The complementarity between financial development and ecological regulation exerts a stronger influence on the renewable transition than either factor alone (Liu et al. 2023). In such environments, firms are better positioned to translate environmental requirements into competitive advantages (Bhuiyan et al. 2023). National climate ambition, measured through the CCPI, is included as an indicator of coercive pressure, while public attention is considered as a potential amplifier of the salience of corporate climate strategies.

Further to the research objectives of this study, we collected data from 2019 to 2023 on an unbalanced panel of 1724 firms (7237 observations), of which 922 (3904 observations) are headquartered in G7 economies, allowing a direct assessment of institutional maturity. The analysis combined firm-level Scope 1 + 2 emissions with a G7 dummy, the CCPI as a measure of national climate ambition, and principal-component indices of Google search intensity for climate-related terms. Using dynamic system–GMM estimators and extensive robustness checks, we find that emission reductions increase profitability, that this effect is stronger for firms in G7 countries and in high-CCPI jurisdictions, and that high levels of public attention further amplify the profitability premium. These results place corporate decarbonisation within the contemporary risk–return calculus, showing that credible national policies and heightened stakeholder scrutiny reinforce private incentives to reduce carbon.

The study contributes to the literature on the economic implications of decisions on corporate emissions by confirming earlier findings (Lee et al. 2015; Lewandowski 2017; Bendig et al. 2023; Ibishova et al. 2024; Khamis et al. 2025) and demonstrating that institutional contexts characterised by sustainable growth, financial stability and international cooperation magnify the profitability effects of abatement. It builds on research highlighting the role of institutional structures in enabling organisational transformation (Nathaniel et al. 2021; Ganda 2022; Dragomir et al. 2023), and extends work on G7 eco-innovation (Nathaniel et al. 2021) and macro-level environmental dynamics (Mukhopadhyay and Nayak 2024; Cai et al. 2025) by analysing the moderating effects of coercive and normative pressures. The findings also advance the literature on climate ambition (Bergmann et al. 2017; Damert et al. 2018; Shui et al. 2025) and stakeholder-driven pressures, complementing evidence on investor and lender behaviour (Bolton and Kacperczyk 2021; Altavilla et al. 2024; Broeders et al. 2024) and work on public attention as measured by Google search intensity (Klaus et al. 2023; Nishi and Peabody 2024).

This article is structured in six sections, the first being the Introduction. Section 2 presents the theoretical framework, a literature review and the formulation of the research hypotheses. Section 3 outlines the methodological strategy adopted. Section 4 reports the estimation results and a discussion thereof. Section 5 details the robustness checks performed. Finally, Section 6 summarises the main conclusions, outlines the study's limitations and suggests potential avenues for future research.

2 | Literature Review and Hypothesis Development

2.1 | Corporate CO_2-Emission Reductions and Firm Profitability

According to the Natural Resource-Based View (NRBV) (Barney et al. 2011; Hart 1995), the mitigation of environmental externalities derived from production processes constitutes a capability with the potential to become a competitive advantage. This perspective holds that firms can develop organisational capabilities by implementing proactive environmental strategies—such as the reduction and prevention of CO_2 emissions—through technological innovations and environmental management routines (Azeem et al. 2025; Benkraiem et al. 2022). Bhuiyan et al. (2023) show that firms integrating sustainability into core operations achieve stronger competitive positioning, confirming that environmental practices can support long-term profitability. These strategies require feedback mechanisms and organisational routines aimed at strengthening the existing resource base and enhancing environmental responsiveness (Bendig et al. 2023; Lee et al. 2015). In line with the RBV and Porter's hypothesis, such capabilities may be transformed into valuable, scarce and inimitable resources, enabling firms to reduce both operational costs—through more efficient resource use—and reputational costs, thereby generating abnormal rents (Hart 1995; Porter and van der Linde 1995).

In line with these theoretical approaches, various empirical studies have examined the link between carbon performance and corporate financial performance (CFP), yielding heterogeneous results depending on the context, the metrics used, and the time horizon considered. In general, a substantial body of empirical literature has found a positive and significant relationship between CO_2 emission reductions and improved CFP, measured via ROA, ROE, Tobin's Q or EBITDA. For example, Lee et al. (2015), using a sample of 362 Japanese manufacturing firms (2003–2010), show that higher levels of CO_2 emissions are associated with lower accounting profitability (ROA). They argue that while the integration of environmental sustainability initiatives into business operations may generate additional budgetary constraints, such integration can lead to both environmental and economic benefits in the long term.

Benkraiem et al. (2022), drawing on 700 observations from Global 100 CK firms, found a positive and significant relationship between carbon performance (logarithm of Scope 1 and 2 emissions, and emission intensity) and Tobin's Q, indicating greater investor appeal towards firms committed to reducing atmospheric emissions. Bendig et al. (2023) confirmed a positive and significant relationship between carbon intensity and financial performance—both accounting-based (ROA) and market-based (Tobin's Q)—in a sample of 465 multinational firms with science-based emission-reduction targets. This suggests that corporate climate-mitigation strategies may enable firms to recoup the costs associated with reducing CO_2 emissions.

In addition, the cost advantage channel is now complemented by evidence that capital markets reward decarbonisation. A global panel of 2768 listed firms shows that each percentage-point decrease in absolute emissions lifts ROA by about five basis points (Ibishova et al. 2024). This finding is reinforced by a meta-analysis covering more than 180 primary estimates, which corroborates a positive mean effect of sustainability practices on both accounting and market-based performance measures (Khamis et al. 2025).

In sector-specific studies, Azeem et al. (2025), analysing 161 multinational firms from highly polluting sectors (2015–2021), found a positive and significant relationship between the reduction of direct CO_2 emissions and ROA, suggesting that climate change mitigation can become a competitive advantage that redefines corporate profitability. Similarly, Senna and de Araujo Moxotó (2025) reported a positive and significant association between carbon emission reduction and CFP—measured through ROA, ROE, and earnings per share—for 73 firms included in Brazil's Carbon Efficiency Index. Their findings underscore the need for institutional incentives adapted to sectoral contexts in emerging markets to support efforts to limit global warming to below 2°C.

These results are consistent with studies showing that an increase in greenhouse gas (GHG) emissions is associated with a decline in financial performance. Salvi et al. (2025) found that rising GHG emissions—as a proxy for accelerating climate change—lead to a decrease in CFP, measured through EBITDA and Tobin's Q. This negative relationship is mitigated by climate finance, particularly through carbon credits, highlighting the need for effective mechanisms to curb rising global temperatures. Similarly, Le and Nguyen-Phung (2024) examined the relationship between GHG emissions—including direct and indirect CO_2 and fluorinated gases—and CFP (ROA and ROE) in a sample of African firms (2005–2021). They found that reducing GHG emissions enhances corporate profitability, especially in highly polluting sectors, reinforcing the importance of investing in zero-emission technologies.

Lewandowski (2017), using an international sample of 1640 firms (2003–2015), reported a positive and significant relationship between emission reductions and ROA, but a negative relationship with Tobin's Q. This suggests that addressing global warming can provide a competitive advantage when aligned with investor expectations. Accordingly, while some firms may adopt proactive climate mitigation strategies, others might adopt more financially cautious, reactive approaches until market uncertainty gradually diminishes.

Ganda (2022), in a sample of 107 listed South African firms (2015–2018), found a positive and significant relationship between carbon performance (total emissions/sales) and CFP (ROA, Tobin's Q, firm value) in the short term. However, in the long term, this relationship becomes negative for ROA and firm value—possibly due to a lack of internal capacity to sustain zero-emission innovation. Meng et al. (2023), analysing 352 Chinese firms from energy-intensive sectors (2013–2020), identified a positive and significant impact of carbon performance on Tobin's Q, though only intertemporally. This suggests that the financial benefits of emission reductions materialise over the long term, as inefficiencies in real-time CO_2 data availability may hamper investor valuation.

By contrast, Wang et al. (2014), in a sample of 69 Australian firms (2010), observed that higher GHG emissions are associated with increased profitability (Tobin's Q), suggesting that in certain contexts, mitigation expenditures may be perceived as obstacles to competitiveness. Similarly, Adu et al. (2023) report a negative and significant relationship between actual CO_2 emission reductions and financial performance (ROA and ROE) in a sample of UK firms, arguing that the high organisational costs of implementing climate strategies may adversely affect short-term profitability.

Beyond accounting and market-based profitability, recent studies indicate that corporate decarbonisation influences both firm valuation and the cost of capital. The pricing channel is equally salient. High-emission US firms earn excess stock returns—the 'carbon premium'—of 15–26 basis points per standard-deviation increase in Scope 1 emissions (Bolton and Kacperczyk 2021), while European banks charge roughly 14 basis points more on loans to polluting borrowers, but reduce spreads for clients that commit to abatement targets (Altavilla et al. 2024). Corporate bond markets exhibit a similar transition-risk premium: a one-standard-deviation rise in emissions widens yield spreads by 23 basis points (Broeders et al. 2024). Collectively, these findings imply that credible carbon-reduction strategies can translate into higher profitability through both operating-cost savings and cheaper external finance. In this regard, the following hypothesis is proposed:

Hypothesis 1. *Corporate year-over-year reductions in CO_2 emissions are positively associated with subsequent profitability.*

2.2 | Institutional Contexts: G7 Versus Non-G7 Economies

Understanding the relationship between carbon emission reductions and corporate profitability is enriched by the perspective of institutional theory. Within this framework, firms are subject to three types of institutional pressure that shape their behaviour in response to environmental sustainability issues, either through formal regulations or through social expectations perceived by stakeholders as normative standards of behaviour (DiMaggio and Powell 1983; Salvi et al. 2025). In particular, corporate leaders face pressures from multiple sources that influence strategic decision-making aimed at ensuring continuity, securing access to resources and pursuing organisational legitimacy (Dragomir et al. 2023). These pressures are articulated through three institutional dimensions that define the firm's operating environment. The first is coercive pressures arising from institutions with formal authority, such as governments and regulatory bodies, which can impose sanctions or provide incentives through binding regulations. Second, mimetic pressures stem from the need to avoid falling behind leading or successful organisations, especially in sectors with no clearly defined environmental regulation. Third, normative pressures originate from professional actors, investors and civil society, who expect behaviours aligned with morally accepted values, such as environmental protection and commitment to climate action (Dragomir et al. 2023). Gao et al. (2019) found that coercive, normative and mimetic pressures jointly influence firms' environmental behaviour, showing that stronger institutional environments promote more proactive environmental practices.

In this context, the intensity and effectiveness of the above pressures vary depending on the degree of institutional development within a country, directly influencing corporate responses to climate change. In countries with more mature institutional structures, the pressures tend to be clearer, more coherent and more capable of driving sustainable organisational transformation (Dragomir et al. 2023; Nathaniel et al. 2021). In addition, Nicolo et al. (2025a) demonstrated that cultural traits—such as uncertainty avoidance and long-term orientation—shape sustainability disclosure, reflecting strong normative institutional pressures.

Institutional theory also suggests that the payoff of environmental investment depends on the quality of formal rules and market infrastructures (North 1990; Aguilera et al. 2007). Environmental-policy stringency (EPS) tests this proposition: across 1999–2019, tighter EPS eroded bank profitability in emerging E7 countries, but the effect was muted in the G7, in which deeper capital markets and stronger governance help absorb compliance costs (Nasim et al. 2025). Similar asymmetries appear for non-financial firms, as more liquid green-finance channels in advanced economies lower the marginal cost of abatement (Altavilla et al. 2024). Moreover, Ganda (2022) argued that the strength of national policies affects the long-term continuity and viability of corporate CO_2 reduction initiatives. Sahu and Choudhary (2025) have shown that circular-economy adoption is shaped by coercive, normative and mimetic pressures, with mature institutional systems providing greater incentives for environmental commitment.

As Mukhopadhyay and Nayak (2024) highlighted, developed and emerging economies differ significantly in their institutional contexts, particularly in governance structures and regulatory frameworks, which in turn influence company priorities. Based on a sample of 2100 firms from G7 and BRICS countries over the period 2013–2022, they found that environmental innovations improve business performance in both groups, albeit with important distinctions: in G7 economies, product innovations yield the strongest effects, whereas in BRICS countries, process innovations are more effective. These findings demonstrate that the institutional environment conditions both the type of eco-innovation promoted by firms and its potential to generate sustainable competitive advantages.

From a macroeconomic perspective, Nathaniel et al. (2021) underscored the importance that G7 countries attach to the use of low-carbon energy sources as part of their commitment to the international climate agenda, as well as the presence of stricter environmental regulatory frameworks than in less developed economies. Their study analysed the impact of economic growth, renewable energy use and nuclear energy on CO_2 emissions in G7 countries over the period 1990–2017. The results show that only nuclear energy is significantly associated with reductions in CO_2 emissions, suggesting that in G7 countries climate policies should be extended beyond renewable sources to include low-carbon technologies such as nuclear power. However, it is essential that the potential of nuclear energy be weighed against the risks associated with radioactive waste management and its limited social acceptance.

These perspectives contrast with the findings of Cai et al. (2025), who identified a positive and significant relationship between the ecological footprint of G7 countries and the strength of their formal institutions between 2000 and 2021. This suggests that, despite robust regulatory frameworks, such institutions may also incentivise resource-intensive industrialisation models to sustain economic growth, thereby generating negative environmental impacts. This tension underscores the notion that institutional quality alone does not guarantee favourable environmental outcomes, although it does provide differentiated capacities to respond to social and regulatory pressures.

Taken together, these studies support the relevance of distinguishing between institutional contexts when analysing the link between sustainability and business performance. G7 countries provide organisational environments characterised by stronger normative and regulatory structures with highly developed regulative, normative and cognitive pillars (Nathaniel et al. 2021). Firms operating within these contexts face more intense and coordinated pressures to align their behaviour with social and political expectations related to climate change (Tuo et al. 2024). Consequently, the marginal benefit of emission reductions on profitability is expected to be greater in G7 contexts, due to their enhanced organisational legitimacy, preferential access to capital and/or reputational gains. Accordingly, the following hypothesis is proposed:

Hypothesis 1a. *The positive relationship posited in Hypothesis 1 is stronger for firms headquartered in G7 countries than for firms in non-G7 economies.*

2.3 | National Climate Performance as a Contingency Factor

To achieve the overarching goal of climate stability, laws and regulations have been enacted at national and regional levels (including, among others: Regulation EU/2021/1119; the

Climate Commitment Act, Washington, USA; and the Act on Promotion of Global Warming Countermeasures, Japan). National climate regulatory institutions formulate policies to mitigate global warming, shaping and reinforcing compliance with net-zero emission targets (Guy et al. 2023), thereby generating increasing regulatory pressures on firms. These pressures not only function as risk-prevention mechanisms, but also compel companies to strategically adjust their internal and external processes in order to actively reduce carbon emissions—an adaptation that may, in turn, strengthen their resource and capability base (Shui et al. 2025; Damert et al. 2018). In this regard, previous literature has emphasised that national institutions with coercive authority act as key drivers of environmental sustainability (Bhuiyan et al. 2023; Farrukh et al. 2022), as well as of the development of concrete CO_2 mitigation actions (Le and Nguyen-Phung 2024; Luo 2019). These institutions establish a framework of incentives and constraints that shape firms' strategic decision-making. Indeed, Nicolo et al. (2025b) found that firms located in more stringent regulatory environments adapt their sustainability reporting more rapidly, underscoring the influence of coercive institutional pressures.

In this context, the CCPI has emerged as a useful tool for capturing the level of national climate ambition. This index annually ranks 64 jurisdictions on emissions trends, renewable-energy penetration, energy use and policy (Germanwatch, NewClimate Institute, and Climate Action Network 2025). Higher CCPI scores coincide with narrower sovereign-bond spreads and lower macro-climate risk, allowing firms to monetize green capabilities through preferential procurement, subsidies or concessional finance. Since national climate policy credibility reduces uncertainty around future carbon costs, firms operating in high-CCPI countries should capture a larger share of the financial upside from emission reductions.

The available empirical evidence offers a diverse perspective on the role of the CCPI in the interaction between climate regulation, corporate action and profitability. For a sample of 650 international manufacturing firms, Bergmann et al. (2017) found that improvements in energy efficiency—as one of the main corporate responses to climate change—were positively associated with higher corporate profitability. Although the CCPI was not a core variable in the analysis, its inclusion as a control for climate policy stringency showed a positive effect on profitability. It can therefore be argued that achieving energy efficiency addresses both corporate interests in improving profitability and global climate mitigation goals.

Similar results were reported by Damert et al. (2018), who, using a sample of 877 suppliers to large multinationals during 2013–2014, found that regulatory pressures—measured via the CCPI and the Institutions and Measures Index (CLIMI)—play a decisive role in the implementation of both internal and external supply chain practices aimed at reducing carbon emissions.

From a broader, sectoral perspective, Shui et al. (2025), based on a sample of 1200 multinational firms listed in the S&P index (2017–2019), identified a positive and significant impact of climate regulatory pressures—measured through the CCPI sub-dimension on national and regional climate policy—on environmental sustainability performance. The effect was especially pronounced in highly emission-intensive industries. However, the authors also caution that organisational responses to such pressures may weaken when firms perceive instability in the institutional environment, contrasting with the notion of consistently strong and effective short-term coercive influence.

In a sector-specific analysis focused on the automotive industry (105 leading firms between 2013 and 2014), Damert and Baumgartner (2018) examined the CCPI as a proxy for regulatory pressure from national regimes. Their results indicate that, contrary to expectations from institutional theory, regulatory pressure did not have a significant impact on the implementation of actions aligned with climate objectives. This lack of effectiveness remained consistent even when alternative indicators such as the Climate Laws, Institutions and Measures Index were employed. The authors suggested that this outcome may be due to a loss of normative effectiveness caused by policy implementation delays, and the fact that many sectoral policies had already been institutionalised for decades.

Additionally, Hirschmann (2025), in a study of 1437 international start-ups, found a negative moderating effect of climate policy stringency—assessed through the CCPI sub-dimension on climate policy—on the relationship between sustainable innovation and corporate growth aspirations. That finding suggests that an overly rigid regulatory environment may discourage the scaling up of environmentally sustainable innovations. This points to the need for a regulatory balance that fosters both climate mitigation and start-up development, generating environmental benefits through improved internal practices and alignment with the organisation's mission.

Taken together, the empirical evidence reveals mixed effects of coercive pressures, though most studies report positive outcomes in the context of climate change. It is therefore argued that when institutions with coercive power adopt and implement national climate regulations, organisations located in those countries tend to align their strategies and processes in response to those requirements.

The selection of the G7 as a reference group is based on its structural importance in the global economy. According to estimates by the International Monetary Fund (2025), those countries account for approximately 28.4% of global GDP, adjusted for purchasing power parity (PPP). In addition, they are responsible for around 25% of CO_2 emissions associated with the global energy system (International Energy Agency 2022). As reported in the World Investment Report (United Nations 2025), several G7 economies consistently rank among the top sources of foreign direct investment (FDI), reinforcing both their role as home countries to globally operating firms and their capacity to project institutional, economic and environmental influence beyond their borders.

The G7 has also reaffirmed its climate and financial leadership by, among other measures, committing to phasing out unabated coal use by 2035, tripling renewable energy capacity and implementing energy transition policies aligned with the objective of limiting global warming to 1.5°C, in line with the Paris Agreement (United Nations 2025). This combination of economic influence, environmental weight and institutional capacity makes the G7 an analytically robust setting in which to assess whether corporate emission reductions translate into stronger financial performance than in other economies.

This may lead to improvements in firms' resources and capabilities, for example, through the use of renewable energy sources that ensure a more stable and potentially more cost-effective supply. In addition, companies may avoid costs associated with regulatory sanctions or reputational losses resulting from non-compliance (Shui et al. 2025). Accordingly, the following hypothesis is proposed:

Hypothesis 2a. *National CCPI scores positively moderate the CO_2-reduction–profitability relationship: The higher a country's CCPI rating, the stronger the association predicted in Hypothesis 1.*

2.4 | Public Online Attention to Sustainability Issues

In an effort to survive and grow in highly competitive environments, firms tend to align their corporate values and behaviours with socially accepted norms and expectations (DiMaggio and Powell 1983). Climate stability—which is primarily disrupted by corporate CO_2 emissions—has become an increasing focus of public scrutiny. Mitigating such emissions not only contributes to the public good, but may also enhance organisational legitimacy, facilitating access to financial resources, improving corporate reputation, securing tax incentives and ultimately generating positive effects on financial performance (Ahmed 2024; Meng et al. 2023). Moreover, environmental proactivity—particularly in ecologically sensitive sectors—requires a strong foundation of informational transparency. In this regard, firms are expected not only to communicate their pro-environmental initiatives, but also to disclose any potential negative impacts of their operations on the environment. Such communication strategies can strengthen stakeholder relationships, even under conditions of uncertainty or operational difficulty (Nishi and Peabody 2024).

Investor-attention models (Da et al. 2011) imply that information salience magnifies valuation effects. Google Search Volume Index (GSVI)–based proxies offer high-frequency gauges of such salience. A systematic review of 56 studies documents that GSVI reliably captures investor attention and affects abnormal returns around ESG events (Ayala et al. 2024). Event-study evidence for Chinese high-tech firms shows that spikes in climate-related search intensity amplify the market reward for emission cuts, particularly under favourable media sentiment (Chen and Mai 2024).

From an organisational perspective, Klaus et al. (2023) analysed how public scrutiny affects environmental performance on a sample of 1393 firms (2015–2020), including US companies, classified according to their emission levels. Using GSVI to capture the level of public attention—high, medium or low—during the announcement of the US withdrawal from the Paris Agreement, they found that the most polluting firms responded with greater environmental proactivity than their counterparts, even in the absence of coercive pressures. This finding suggests that public attention can induce organisational behaviours oriented towards climate change mitigation.

Along similar lines, Nishi and Peabody (2024) examined a sample of 92 US firms from CO_2-emitting sectors between 2010 and 2017. They found that investor and consumer attention to environmental stewardship—measured via two separate GSVI indices—had a positive and significant effect on the adoption of environmental sustainability measures, particularly those related to the reduction of GHG emissions.

Furthermore, Ahmed (2024) investigated the effect of social attention to climate stability on the pricing dynamics of eco-friendly assets (e.g., clean energy stocks), finding a strong short-term sensitivity of such assets to public attention. Nicolò et al. (2024) showed that cultural orientations significantly influence sustainability disclosure in the banking sector, with stronger normative expectations leading to broader reporting.

Other studies have employed GSVI to analyse the impact of investor attention on climate change, fossil fuel divestment, carbon pricing, CO_2 emission reductions, climate risks and the political implications of said issues on energy stock performance (Jia et al. 2023). Oil futures prices (Lin et al. 2024) and the profitability of fossil-fuel extraction firms (Ouadghiri et al. 2022).

The findings are mixed, showing both positive relationships—such as those between attention to CO_2 reductions, regulatory risk and fossil fuel divestment on the one hand, and share returns or profitability on the other (Ouadghiri et al. 2022; Lin et al. 2024)—and negative relationships, particularly between attention to physical climate risk and stock performance (Lin et al. 2024; Jia et al. 2023).

Taken together, the literature suggests that public attention exerts significant pressure on organisational behaviour. In contexts in which firms actively reduce their carbon emissions, a national environment characterised by high levels of attention to environmental sustainability in general—and to climate change in particular—may enhance organisational legitimacy, amplify positive reputational effects, and thereby strengthen the profitability premium associated with mitigation efforts. Accordingly, the following hypothesis is proposed:

Hypothesis 2b. *Country-level online attention to sustainability, measured by principal components of multiple GSVI terms, positively moderates the CO_2-reduction–profitability relationship.*

3 | Data and Methodology

3.1 | Data and Sample Description

The sample was selected to test the above hypotheses based on three criteria. First, given that the Paris Agreement was signed by nearly 194 countries in 2015 and entered into force on 4 November 2016 (United Nations 2023), it was considered essential to adopt a time-frame that allowed firms to implement the measures necessary to align their strategies with the climate agreement objectives, particularly the net-zero emissions target. This adoption may have been voluntary or in response to institutional pressures. Although GHG mitigation frameworks, such as California's Low Carbon Fuel and Directive 2010/75/EU, already existed, national commitments became more ambitious after the Agreement, leading to the 2050 climate neutrality goal (Regulation EU/2021/1119).

Second, following the methodological approach of García-Sánchez et al. (2023), multinational firms were selected based on the availability of information regarding their environmental sustainability practices in general, and decarbonisation efforts in particular, together with financial and economic data, as reported in the LSEG database. Based on these criteria, an initial sample of 9190 observations was obtained for the period 2018–2023.

Third, firms without complete information for the variables included in the model, as well as those located in countries lacking CCPI data, were excluded. The final sample therefore consists of an unbalanced panel dataset of 7237 observations for the period 2019–2023, corresponding to 1724 multinational firms across 10 sectors. In addition, a sub-sample of firms located in the G7 economies, comprising 3904 observations for 922 firms, was constructed. This sub-sample enabled the exploration of differences between advanced economies with strong climate governance frameworks and the broader multinational sample. Figure 1 presents the percentage distribution of the analytical sample by economic sector, following the LSEG classification.

Figure 2 presents the number of observations for the 31 countries included in the sample, along with each country's score in the climate policy sub-dimension of the 2023 CCPI. In addition, countries are grouped according to their overall performance level in the CCPI (high, medium, low and very low), allowing for an initial view of the diversity in political commitment to addressing climate change among the countries analysed. This offers a preliminary perspective on policy alignment in addressing climate challenges. For instance, countries such as Denmark and the Netherlands, classed as high-performers, report the highest climate policy scores, while countries such as Japan, Brazil and Turkey, categorised as very low performers, display significantly lower values.

3.2 | Variables

To measure corporate CO_2 emission reductions, this study followed an approach, widely adopted in the literature, which interprets such reductions as a signal of corporate commitment to lowering the environmental footprint—associated with improvements in strategic capabilities and available technical-operational resources (Azeem et al. 2025; Salvi et al. 2025). Accordingly, the independent variable, CO_2Reduction, was calculated as the winsorised year-on-year change in total CO_2 emissions reported by each firm.

Regarding corporate profitability, ROA is used as the dependent variable, in line with previous studies (Azeem et al. 2025; Le and Nguyen-Phung 2024; Lewandowski 2017). This accounting measure reflects the efficiency with which a firm converts its organisational resources into economic returns. In the context of environmental strategies, ROA enables the assessment of whether emission reduction efforts are leading to a more effective use of available assets (Azeem et al. 2025).

For the moderating variables that capture institutional pressures, the CCPI is employed as a proxy for national climate policy ambition. Developed by Germanwatch, the NewClimate Institute and the Climate Action Network, this index captures national and regional regulatory pressures on climate change, as well as countries' international commitment to advancing climate-related regulations and agreements (Shui et al. 2025). The CCPI includes four categories: climate policy, GHG emissions, renewable energy use and energy consumption. The index ranges from 0 to 100, where 0 reflects poor performance—associated with high emissions, low renewable energy use, high energy consumption and insufficient climate ambition or policies—while 100 indicates strong performance, characterised by low emissions, extensive use of renewable energy, energy efficiency and high climate policy ambition.

Regarding public attention to environmental sustainability, the variables EcoRA and CAI were defined. These variables were derived from a Principal Component Analysis (PCA) based on public attention engagement with climate-related search terms. The list of terms was constructed after Ahmed (2024), who used the following keywords: 'climate change', 'climate risk', 'greenhouse gas', 'greenhouse gas

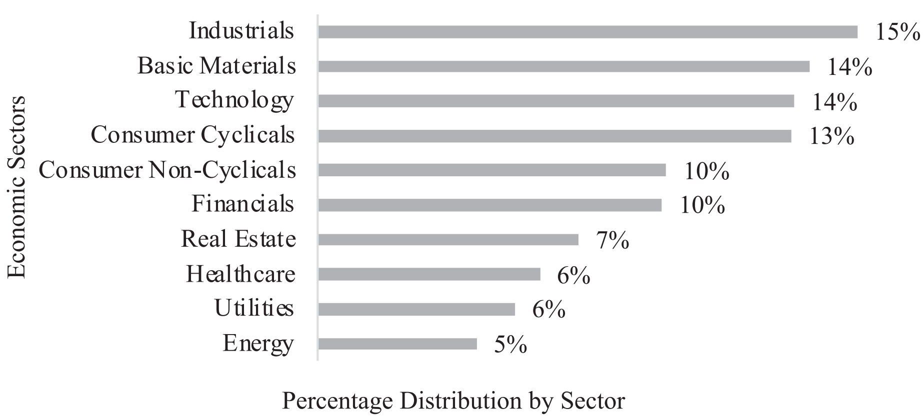

FIGURE 1 | Sectoral representation of the sample. *Source:* authors' own compilation.

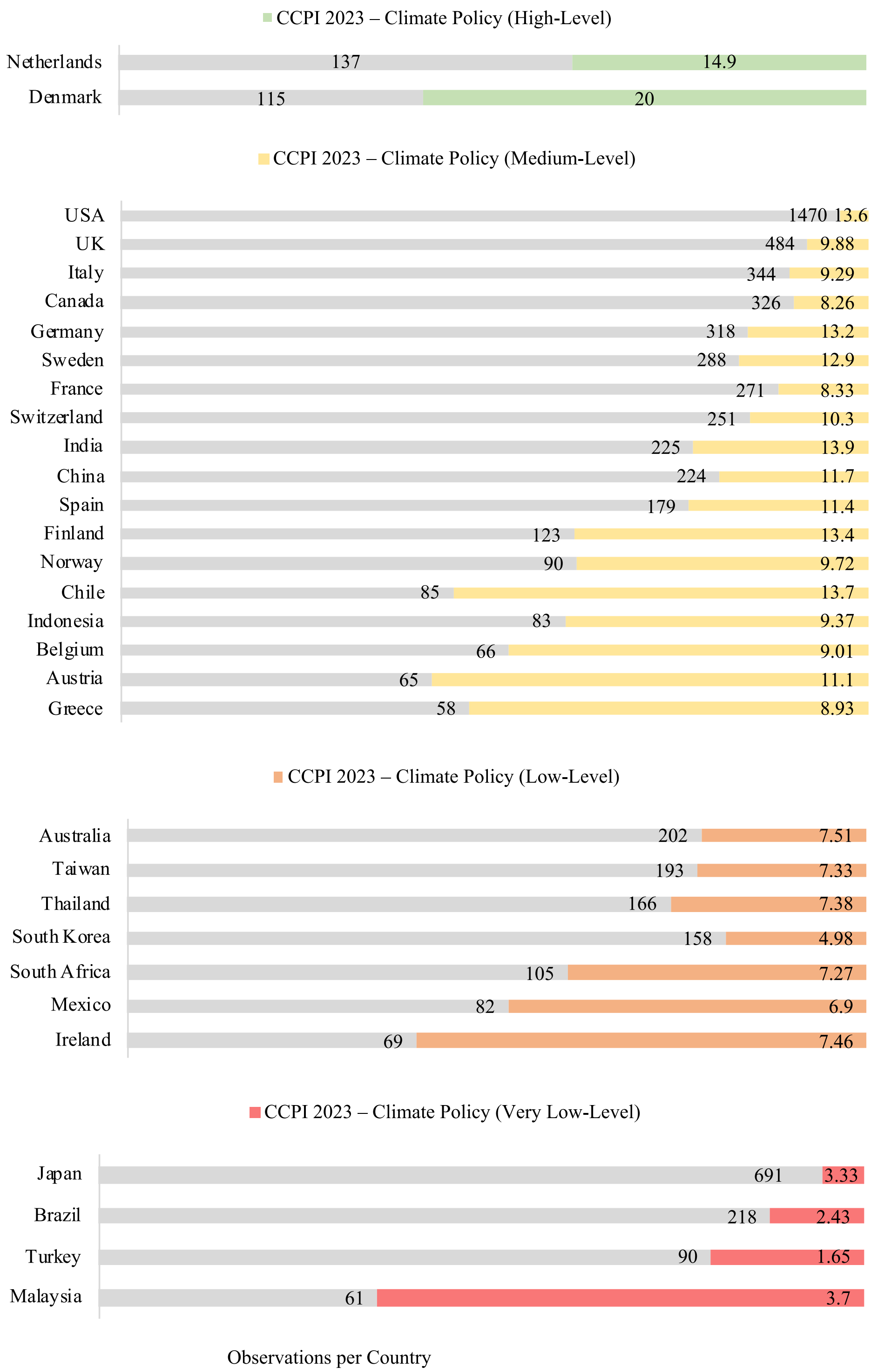

FIGURE 2 | Number of observations and climate policy scores by country (CCPI 2023), grouped by performance level. Source: authors' elaboration based on publicly available data from https://ccpi.org/

emissions', 'biodiversity loss', 'carbon footprint', 'carbon emission trading', 'global warming', 'effects of global warming and climate change', 'deforestation', 'renewable energy', 'green energy', 'renewable resource', 'non-renewable resource', 'climate change mitigation' and 'climate crisis'. The selection of these terms was based on their relevance to public environmental awareness and corporate climate engagement, and they collectively explain approximately 60% of the variance in the underlying dataset.

The PCA yielded two components. First, PC1—Ecological Risk Awareness (EcoRA): this component reflects concerns for structural environmental risks and natural resource management. It loads strongly on terms such as 'climate risk', 'greenhouse gas', 'biodiversity loss', 'renewable resources', and 'non-renewable resources'. Second, PC2—Climate Action Interest (CAI): this component captures public engagement with ongoing climate challenges and transition strategies. It includes high loadings on terms such as 'climate change', 'carbon footprint', 'deforestation', 'renewable energy', 'green energy', and 'climate crisis'.

Additionally, to avoid potential biases in the results, control variables were included to account for both organisational resources and capabilities, as well as corporate governance characteristics. In line with earlier literature (e.g., Benkraiem et al. 2022; Meng et al. 2023; Nathaniel et al. 2021; Bergmann et al. 2017), certain controls were introduced. Specifically, with respect to resources and capabilities, the logarithm of total current assets was included as a proxy for firm size (Size). Financial leverage (Leverage), measured as the debt-to-assets ratio, was taken into account, and Tobin's Q was incorporated to capture the extent to which the firm's strategic resources and capabilities are recognised by the market, as it reflects the ratio between the market value and book value of assets. CAPEX, defined as the proportion of capital expenditure relative to sales, was used to control for the firm's investment intensity and orientation towards future growth.

Furthermore, to take into account the use of clean energy, the logarithm of total renewable energy consumption was included (RenewableEnergy). Finally, an indicator of energy efficiency (EnergyEfficiency) was also incorporated.

With regard to corporate governance characteristics, this study follows the approach adopted in previous literature which identified key governance factors influencing environmental sustainability decisions in general, and CO_2 emission reductions in particular (Elsayih et al. 2021; Konadu et al. 2022; Mohy-ud-Din et al. 2025). In this context, the variable BGD refers to the percentage of women serving on the board of directors. CEO Duality takes the value 1 if the CEO also holds the position of chair of the board, and 0 otherwise. CSR-SC is a binary variable that is assigned a value of 1 when a specialised committee on corporate social responsibility or sustainability exists within the board structure, and 0 otherwise. Table 1 presents the main variables used in the analysis, along with a summary of their definitions and roles in capturing environmental performance,

TABLE 1 | Variables overview.

Variables	Description	Variables' source	Authors
ROA	Return on assets measures firm profitability	LSEG	Azeem et al. (2025)
CO_2Reduction	Year-over-year winsorised change in CO_2 emissions	Constructed using the CO_2 emissions variable from LSEG	Azeem et al. (2025) Salvi et al. (2025)
CO_2Decline	Dummy variable. It takes on value 1 if CO_2 emissions decreased from 1 year to the next, 0 otherwise	Constructed using the CO_2 emissions variable from LSEG	
CCPI	Country-level Climate Change Performance Index	Climate Change Performance Index website[a]	Damert and Baumgartner (2018) Shui et al. (2025)
EcoRA	Ecological Risk Awareness: captures firm concern for environmental limits and biodiversity	Google Search Volume Index	Ahmed (2024)
CAI	Climate Action Interest: reflects firm engagement with issues like carbon footprint and renewable solutions	Google Search Volume Index	
Size	Log of total current assets	LSEG	Benkraiem et al. (2022)
Leverage	Financial leverage (debt-to-assets ratio)	LSEG	Meng et al. (2023)
TobinQ	Market value relative to book value	LSEG	Benkraiem et al. (2022)
CAPEX	Capital expenditures	LSEG	
RenewableEnergy	Log of total renewable energy use	LSEG	Nathaniel et al. (2021)
EnergyEfficiency	Proxy for firm energy efficiency	LSEG	Bergmann et al. (2017)
BGD	Percentage of women on the board of directors	LSEG	Konadu et al. (2022)
CEO Duality	Dummy variable. The variable takes on value 1 if CEO is also board chair, 0 otherwise	LSEG	Elsayih et al. (2021)
CSR-SC	Dummy variable. The variable takes on value 1 if a CSR or sustainability committee exists on the board	LSEG	Mohy-ud-Din et al. (2025)

Note: The table provides an overview of the key variables used in the analysis, including definitions, measurement details and data sources. Variables cover corporate environmental performance, financial indicators and governance characteristics.
[a]https://ccpi.org/.

financial outcomes and firm-level governance characteristics relevant to the analysis.

Table 2, on the other hand, provides an overview of the variables used in the empirical analysis. The sample revealed substantial variability in both financial and environmental indicators, that is consistent with the cross-country and cross-sectoral sample, and underscores the institutional, regulatory and market differences. The wide dispersion observed reflects the diverse orientations, operational structures and sustainability commitments of the firms under analysis.

3.3 | Empirical Strategy and Estimation Approach

To test the hypotheses we developed, a panel dataset was generated, including firm and sector fixed effects to control unobserved heterogeneity and sector-specific characteristics. All variables were lagged by 1 year in order to prevent simultaneity bias and to shed light on the causality between dependent and independent variables. The analysis was conducted on both the full sample and a G7 sub-sample to examine institutional differences, as outlined in Hypothesis 1a. The models estimated are as follows:

1. Hypothesis 1: Full sample

$$ROA_t = \alpha + CO_2Reduction_{t-1} + RenewableEnergy_{t-1} + EnergyEfficiency_{t-1} + \sum X_{t-1} + \varepsilon_{t-1} \quad (1)$$

2. Hypothesis 1a: G7 countries

$$ROA_t = \alpha + CO_2Reduction_{t-1} + RenewableEnergy_{t-1} + EnergyEfficiency_{t-1} + \sum X_{t-1} + \varepsilon_{t-1} \quad (2)$$

Where X_{t-1} denotes firm-level controls (governance and financials).

Moreover, to test Hypothesis 2a and Hypothesis 2b, we enriched the baseline models by including interaction terms between firm-level emission reductions and three moderators: CCPI, capturing national climate ambition (Hypothesis 2a), and EcoRA and CAI, reflecting stakeholder interest in climate action and energy transition (Hypothesis 2b).

These interactions allowed us to assess whether the profitability implications of CO_2 abatement strategies depend on the broader institutional environment and stakeholder salience. The estimated specifications are as follows:

3. Hypothesis 2a: Full sample

$$ROA_{t,\,full\,sample} = \alpha + CO_2Reduction_{t-1} + RenewableEnergy_{t-1} + EnergyEfficiency_{t-1} + CCPI_{t-1} + Inter1_{t-1} + \sum X_{t-1} + \varepsilon_{t-1} \quad (3)$$

4. Hypothesis 2a: G7 countries

$$ROA_{t,\,G7} = \alpha + CO_2Reduction_{t-1} + RenewableEnergy_{t-1} + EnergyEfficiency_{t-1} + CCPI_{t-1} + Inter1_{t-1} + \sum X_{t-1} + \varepsilon_{t-1} \quad (4)$$

Where Inter1 is the interaction between CO_2Reduction and CCPI.

5. Hypothesis 2b (EcoRA): Full sample

$$ROA_{t,\,full\,sample} = \alpha + CO_2Reduction_{t-1} + RenewableEnergy_{t-1} + EnergyEfficiency_{t-1} + EcoRA_{t-1} + Inter2_{t-1} + \sum X_{t-1} + \varepsilon_{t-1} \quad (5)$$

6. Hypothesis 2b (EcoRA): G7 countries

$$ROA_{t,\,G7} = \alpha + CO_2Reduction_{t-1} + RenewableEnergy_{t-1} + EnergyEfficiency_{t-1} + EcoRA_{t-1} + Inter2_{t-1} + \sum X_{t-1} + \varepsilon_{t-1} \quad (6)$$

Where Inter2 is the interaction between CO_2Reduction and EcoRA.

7. Hypothesis 2b (CAI): Full sample

$$ROA_{t,\,full\,sample} = \alpha + CO_2Reduction_{t-1} + RenewableEnergy_{t-1} + EnergyEfficiency_{t-1} + CAI_{t-1} + Inter3_{t-1} + \sum X_{t-1} + \varepsilon_{t-1} \quad (7)$$

8. Hypothesis 2b (CAI): G7 countries

$$ROA_{t,\,G7} = \alpha + CO_2Reduction_{t-1} + RenewableEnergy_{t-1} + EnergyEfficiency_{t-1} + CAI_{t-1} + Inter3_{t-1} + \sum X_{t-1} + \varepsilon_{t-1} \quad (8)$$

Where Inter3 is the interaction between CO_2Reduction and CAI.

4 | Results and Discussion

4.1 | Impact of CO_2 Emission Reduction on Firm Profitability

The results presented in Table 3 provide empirical support for Hypothesis 1 and Hypothesis 1a, which show a positive relationship between corporate CO_2 emission reduction and firm profitability. The coefficient of CO_2 reduction was positive and statistically significant in both the full sample (1) and the G7 sub-sample (2). This suggests that firms engaging in decarbonisation efforts tend to achieve better financial performance over time. These results are consistent with previous studies on this topic, including those by Lee et al. (2015), Lewandowski (2017), Ganda (2022), Bendig et al. (2023), Ibishova et al. (2024), Le and Nguyen-Phung (2024), Salvi et al. (2025), Khamis et al. (2025), Azeem et al. (2025) and Senna and de Araujo Moxotó (2025). However, they do not corroborate the findings of Wang et al. (2014) and Adu et al. (2023) for Australian and UK samples, respectively. Indeed, those authors observed a negative relationship between reducing CO_2 emissions and economic and financial profitability, suggesting that this effect is a consequence of the high organisational costs involved in implementing climate strategies.

Nonetheless, we confirm that this effect is also strong in G7 countries, consistent with Hypothesis 1a, which argues that institutional context matters. In more advanced economies, the

TABLE 2 | Descriptive statistics.

Variables	Obs	Mean	Std. dev.	Min	Max
CO_2Reduction	5335	0.031	0.26	−1.049	1.025
CO_2Decline	5335	0.692	0.462	0	1
ROA	7237	0.073	0.089	−0.888	3.729
RenewableEnergy	7237	3209698.9	23,537,968	0	6.317e+08
EnergyEfficiency	7237	275.705	17453.277	−3313.282	1445837.5
BGD	7237	25.275	14.282	0	75
CEODuality	7237	0.31	0.462	0	1
CSR-SC	7237	0.871	0.335	0	1
CCPI	7237	45.276	18.355	0	76.67
Size	7237	9.142e+09	3.403e+10	2909135.3	1.154e+12
Leverage	7237	0.206	0.162	0	2.361
TobinQ	7237	0.27	0.401	−24.857	7.837
CAPEX	7237	0.372	16.056	−1	123.164
EcoRA	7237	0.214	2.547	−0.871	17.697
CAI	7237	0.906	1.536	−2.927	5.963

Note: The table presents the descriptive measures (mean, standard deviation, min, max) for the variables included in the regression models.

financial benefits of emission reductions appear pronounced, implying that the institutional environment can amplify the returns of corporate action. Thus, we shed light on the role that the institutional structures that characterise mature economies play at the corporate level. In this regard, in addition to their impact on organisational transformation toward more sustainable corporations (Nathaniel et al. 2021; Ganda 2022; Dragomir et al. 2023; Mukhopadhyay and Nayak 2024; Cai et al. 2025), our research demonstrates the potentiating role that G7 coercive and normative pressures play in the economic impact derived from them, in line with evidence that institutional pressures jointly shape firms' environmental behaviour (Gao et al. 2019; Nicolo et al. 2025a) and contribute to competitive advantage through corporate sustainability practices (Bhuiyan et al. 2023).

Additional insights emerge from control variables: the use of renewable energy is significantly associated with ROA in the G7 sub-sample but not in the full sample, indicating that clean energy strategies may be more efficiently integrated or rewarded in developed markets. Board gender diversity is associated with a positive and significant effect in both the full sample and G7 subsample, suggesting that more diverse leadership teams may contribute to improved performance across the board. Interestingly, energy efficiency is negatively associated with profitability in the full sample, possibly reflecting short-term costs or delayed gains from implementation.

These findings support the notion that proactive environmental behaviour can be financially advantageous, and that such benefits are magnified in stronger institutional environments like the G7.

4.2 | Impact of National Policies and People's Attention to Firm Profitability

Table 4 presents the results of testing Hypothesis 2a and Hypothesis 2b, which explore how contextual and stakeholder-level factors moderate the relationship between corporate CO_2 reduction and performance. In particular, we examined interactions between CO_2 reduction and CCPI, firm-level public environmental interest (EcoRA) and firm-level attention to climate action (CAI).

The main effect of CO_2 reduction remained positive and statistically significant across all specifications, lending further support to Hypothesis 1 and Hypothesis 1a. The coefficients are stronger within the G7 sub-sample, suggesting that institutional environments continue to play a reinforcing role. This pattern is consistent with evidence that national institutional and cultural characteristics—such as the strictness of regulation, long-term planning orientation and uncertainty avoidance—affect how firms disclose sustainability information and implement environmental strategies (Nicolò et al. 2024). In Models 1 and 2, the interaction between CO_2 reduction and CCPI (Inter1) is negative, but not statistically significant, offering only limited support for Hypothesis 2a. These results are, however, consistent with the contradictory effects observed by Bergmann et al. (2017), Damert and Baumgartner (2018), Shui et al. (2025) and Hirschmann (2025) when analysing the direct impact of this index on organisational environmental transformation.

Greater support, however, emerges for Hypothesis 2b, particularly in Models 4–6, which introduce interactions with firm-level environmental attention. In Models 3 and 4, the interaction

TABLE 3 | Regression results—Hypothesis 1/Hypothesis 1a.

Variables	(1) Full sample ROA	(2) G7 ROA
CO_2Reduction	0.0101***	0.0118**
	(0.00331)	(0.00510)
TotalRenewableEnergy	0.000486	0.00201**
	(0.000651)	(0.000835)
EnergyEfficiency	−0.000449*	−0.00734
	(0.000261)	(0.0132)
BGD	0.000330**	0.000316**
	(0.000134)	(0.000145)
CEODuality	0.00187	0.00766
	(0.00503)	(0.00559)
CSR-SC	0.00154	0.0100
	(0.00675)	(0.00707)
Size	0.00189	0.000144
	(0.00246)	(0.00184)
Leverage	−0.0322	0.0160
	(0.0219)	(0.0227)
TobinQ	−0.00264***	0.00207
	(0.000582)	(0.0136)
CAPEX	2.21e−05*	−2.71e−06
	(1.14e−05)	(8.36e−06)
Constant	0.0450	0.0410
	(0.0556)	(0.0415)
R-squared	0.0145	0.321
Fe	Sector	Sector
Observations	7237	3904
Number of id	1724	922

Note: The table presents fixed-effects regression results examining the impact of CO_2 reduction and environmental variables on firm profitability. Column 1 shows estimates for the full sample, while Column 2 focuses on firms included in G7 countries. Statistical significance: ***$p<0.01$, **$p<0.05$, *$p<0.1$.

between CO_2 reduction and EcoRA (Inter2) is negative but not significant in the full sample, while EcoRA is strongly positive and significant in the G7 sub-sample. This suggests that, in advanced economies, general awareness of ecological risk may enhance a firm's performance. This proactive tendency aligns with evidence showing that larger firms and those operating in environmentally sensitive sectors anticipate alignment with stringent regulatory requirements (CSDR/ESRS) to mitigate legitimacy threats arising from increasing coercive institutional pressure (Nicolo et al. 2025b). More evidence appears in Models 7 and 8, in which the interaction between CO_2 reduction and CAI (Inter3) is negative and significant in the G7 sub-sample. This indicates that firms operating in environments with higher public sensitivity to climate crises may face greater scrutiny or expectations, which could limit the financial upside of standard emission-reduction efforts. At the same time, CAI is positive and significant in both sub-samples, suggesting that public attention to climate issues can still benefit firms more broadly, likely via reputational or market-based mechanisms. This evidence corroborates findings by Klaus et al. (2023) and Nishi and Peabody (2024), who examined the impact of social attention, as determined by Google searches, on environmental performance and emissions reduction.

Overall, the results lend partial support to Hypothesis 2a, but more clearly support Hypothesis 2b, emphasising that the effectiveness of corporate decarbonisation strategies is shaped by stakeholder attention, especially in G7 countries.

5 | Robustness Tests

To validate the reliability of the main findings, two sets of robustness checks were performed. For Hypothesis 1 and Hypothesis 1a, we implemented a two-step approach: first, we substituted the key independent variable to test whether the results are sensitive to the way CO_2 reduction is measured; second, we applied a Generalized Method of Moments (GMM) estimation using instrumental variables to address potential endogeneity concerns and reinforce the causal interpretation. For Hypothesis 2a and Hypothesis 2b, given the complexity of the interaction terms, we conducted the robustness test using only the GMM approach to directly assess the robustness of the moderating effects under potential endogeneity.

5.1 | Robustness Check Hypothesis 1/ Hypothesis 1a: First Step

In Table 5, the independent variable CO_2 reduction was replaced with a binary indicator (CO_2Decline) capturing whether a firm reduced emissions in a given year. The results, while directionally similar to the main model, are weaker. In the full sample, the relationship between emission reduction and profitability was statistically insignificant. In contrast, within the G7 subsample, the coefficient was positive and significant, suggesting that firms in developed economies might benefit more visibly from consistent annual reductions in CO_2. These mixed results suggest that while the continuous measure captures more nuanced changes in emissions (and their financial impacts), the binary measure may not detect variation in the intensity or scale of reductions. The weaker performance of this alternative specification highlights potential measurement limitations when environmental outcomes are simplified to a binary indicator.

5.2 | Robustness Check Hypothesis 1/ Hypothesis 1a: Second Step

The second step of the robustness check is presented in Table 6, which reports the GMM estimation to control for endogeneity. The results show greater alignment with the main findings than earlier specifications. In both models, CO_2 reduction is positively

TABLE 4 | Regression results—Hypothesis 2a/Hypothesis 2b.

Variables	(1) Full sample ROA	(2) G7 ROA	(3) Full sample ROA	(4) G7 ROA	(5) Full sample ROA	(6) G7 ROA
CO_2Reduction	0.0141*	0.0174*	0.0101***	0.0105**	0.0112***	0.0210**
	(0.00739)	(0.00991)	(0.00331)	(0.00506)	(0.00398)	(0.00817)
RenewableEnergy	0.000993	0.00210***	0.00105*	0.00163*	0.000586	0.00159*
	(0.000732)	(0.000770)	(0.000583)	(0.000850)	(0.000601)	(0.000855)
EnergyEfficiency	−0.000558	−0.00821	−0.000563*	−0.00810	−0.000599*	−0.0144
	(0.000622)	(0.0183)	(0.000313)	(0.0141)	(0.000323)	(0.0110)
Inter1	−9.13e-05	−0.000136				
	(0.000151)	(0.000219)				
CCPI	0.000119	−0.000498***				
	(0.000111)	(0.000141)				
Inter2			−0.000387	−0.00411		
			(0.00118)	(0.0104)		
EcoRA			−0.000483	0.0204***		
			(0.000701)	(0.00406)		
Inter3					−0.00223	−0.00622**
					(0.00174)	(0.00274)
CAI					0.00376***	0.00447***
					(0.000797)	(0.000832)
BGD	0.000371***	0.000388***	0.000393***	0.000213	0.000234*	0.000131
	(0.000129)	(0.000145)	(0.000123)	(0.000146)	(0.000122)	(0.000149)
CEODuality	0.00294	0.00395	0.00251	0.00487	0.00321	0.00923
	(0.00398)	(0.00405)	(0.00483)	(0.00557)	(0.00478)	(0.00565)
CSR-SC	0.00148	0.00988**	0.00158	0.00810	−0.000787	0.00795
	(0.00465)	(0.00498)	(0.00689)	(0.00711)	(0.00702)	(0.00705)
Size	−0.000106	−0.000611	−0.000276	−0.000333	−0.000991	0.000395
	(0.00170)	(0.00163)	(0.00274)	(0.00183)	(0.00274)	(0.00186)
Leverage	−0.0259*	0.000895	−0.0276	0.00846	−0.0217	0.0250
	(0.0133)	(0.0151)	(0.0218)	(0.0226)	(0.0220)	(0.0227)
TobinQ	−0.00237	−0.00364	−0.00259***	−0.00418	−0.00231***	0.00593
	(0.00161)	(0.0111)	(0.000570)	(0.0131)	(0.000531)	(0.0135)
CAPEX	−4.00e-07	5.31e-06	2.91e-06	5.16e-06	1.80e-05	5.90e-06
	(7.40e-05)	(5.75e-05)	(1.12e-05)	(8.15e-06)	(1.40e-05)	(7.52e-06)
Constant	0.0768**	0.0787**	0.0851	0.0641	0.108*	0.0374
	(0.0361)	(0.0364)	(0.0635)	(0.0416)	(0.0637)	(0.0421)
R-squared	0.0145	0.0321	0.0139	0.0357	0.0313	0.0595
Fe	sector	sector	sector	sector	sector	sector
Observations	7237	3904	7237	3904	7237	3904
Number of id	1724	922	1724	922	1724	922

Note: The table presents regression models examining how climate policy stringency (CCPI) and stakeholder environmental attention (EcoRA and CAI) moderate the relationship between CO_2 emission reduction and firm profitability. Statistical significance: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

TABLE 5 | Hypothesis 1/Hypothesis 1a robustness check: Alternative CO_2 reduction measure.

	(1)	(2)
	Full sample	G7
Variables	ROA	ROA
CO_2Decline	−0.00311	0.00402**
	(0.00304)	(0.00192)
RenewableEnergy	0.000278	0.000699
	(0.000523)	(0.000813)
EnergyEfficiency	−0.000422*	0.000485
	(0.000228)	(0.00878)
BGD	0.000187	0.000327*
	(0.000120)	(0.000178)
CEODuality	−0.000380	0.00140
	(0.00331)	(0.00621)
CSR-SC	0.00178	0.00618
	(0.00406)	(0.00467)
Size	0.000166	0.0119**
	(0.00153)	(0.00603)
Leverage	−0.0314*	−0.0247
	(0.0178)	(0.0248)
TobinQ	−0.000549	−0.0386***
	(0.00123)	(0.0134)
CAPEX	−3.11e-06	1.10e-06
	(6.27e-06)	(7.53e-06)
Constant	0.0908**	−0.200
	(0.0355)	(0.134)
R-squared	0.001	0.020
Observations	7237	3904
Number of id	1724	922

Note: The table presents fixed-effects regression results using an alternative variable indicating whether a firm reduced its CO_2 emissions (as binary variable) in a given year. Column 1 reports estimates for the full sample, while column 2 focuses on G7 firms. Significance levels: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

TABLE 6 | Hypothesis 1/Hypothesis 1a robustness check: GMM estimations.

	(1)	(2)
	Full sample	G7
Variables	ROA	ROA
CO_2Reduction	0.0718*	0.448**
	(0.0411)	(0.174)
RenewableEnergy	0.00565**	0.0247
	(0.00230)	(0.0167)
EnergyEfficiency	0.00322	0.232
	(0.0202)	(0.881)
BGD	5.77e-05	−0.00153
	(0.000263)	(0.00186)
CEODuality	0.0484***	0.136
	(0.0157)	(0.0858)
CSR-SC	0.0311	−0.168
	(0.0276)	(0.122)
Size	−0.0139***	−0.0260
	(0.00394)	(0.0304)
Leverage	−0.0962*	−0.333
	(0.0532)	(0.287)
TobinQ	−0.00796	0.0689
	(0.0175)	(0.162)
CAPEX	−0.00411	−0.00198
	(0.00261)	(0.00641)
Constant	0.287***	0.498
	(0.0923)	(0.600)
Observations	7237	3904
Number of id	1724	922
Hansen-Test	0.123	0.176
AR(1)	0.000	0.001
AR(2)	0.120	0.101

Note: The table reports the results of GMM regressions assessing the impact of CO_2 reduction on firm profitability, controlling for potential endogeneity. Column 1 shows GMM estimates for the all sample, while column 2 presents GMM estimates for the G7 countries. Statistical significance: ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

associated with firm profitability, with the relationship being greater in magnitude in the second model that focused on G7 firms. This consistency provides robust support for both Hypothesis 1 and Hypothesis 1a, that is, corporate emission-reduction efforts, when sustained over time, can enhance financial performance. While some caution is warranted due to variations in coefficient magnitude, indicating some sensitivity to model structure, the direction and significance of the main variable of interest remain stable. This reinforces confidence in the positive role of CO_2 mitigation strategies, particularly for firms adopting a long-term or innovation-oriented perspective. Other control variables exhibit mixed robustness, suggesting that secondary relationships may depend more heavily on model design or contextual factors.

However, the core result holds across specifications, offering strong empirical support for our hypotheses. In addition, standard specification tests further corroborate the reliability of the GMM models. The Hansen Test for over-identifying restrictions supports the validity of the chosen instruments, particularly in the G7 sub-sample, while the Arellano–Bond tests—AR(1) and AR(2)—confirm the presence of first-order, but not second-order, serial correlation, consistent with the assumptions in the models. These diagnostics justify the use of the selected instrument set and

TABLE 7 | Hypothesis 2a/Hypothesis 2b: GMM estimations.

Variables	(1) Full sample ROA	(2) G7 ROA	(3) Full sample ROA	(4) G7 ROA	(5) Full sample ROA	(6) G7 ROA
CO_2Reduction	0.142	0.445	0.0714*	0.493**	0.282***	0.427**
	(0.0931)	(0.578)	(0.0403)	(0.216)	(0.0613)	(0.209)
RenewableEnergy	0.00370	0.0185	0.00499**	0.0305	0.00352	0.0164
	(0.00269)	(0.0179)	(0.00228)	(0.0196)	(0.00432)	(0.0201)
EnergyEfficiency	0.00137	0.501	0.000139	0.621	−0.00393	0.470
	(0.0192)	(1.050)	(0.0204)	(1.092)	(0.0248)	(0.989)
BGD	−3.20e-05	−0.000316	0.000138	−0.000924	0.000488	−0.000790
	(0.000276)	(0.00243)	(0.000268)	(0.00221)	(0.000563)	(0.00202)
CEODuality	0.0515***	0.0586	0.0498***	0.289**	0.0763***	0.105
	(0.0171)	(0.112)	(0.0160)	(0.132)	(0.0260)	(0.0908)
CSR-SC	0.0373	−0.194	0.0375	−0.174	−0.0781	−0.209
	(0.0292)	(0.138)	(0.0290)	(0.145)	(0.0509)	(0.150)
inter1	−0.00163	0.00145				
	(0.00177)	(0.0124)				
CCPI	0.000281	−0.00156				
	(0.000193)	(0.00175)				
inter2			0.00556	0.323		
			(0.0212)	(0.567)		
EcoRA			−0.00143	−0.0768		
			(0.00133)	(0.0583)		
inter3					−0.00721	−0.126**
					(0.0204)	(0.0604)
CAI					−0.00255	0.00932*
					(0.00188)	(0.00552)
Size	−0.0130***	−0.0200	−0.0143***	−0.0198	−0.00717	−0.00715
	(0.00415)	(0.0308)	(0.00394)	(0.0350)	(0.00750)	(0.0285)
Leverage	−0.0696	−0.433	−0.103*	−0.685*	−0.213**	−0.215
	(0.0596)	(0.279)	(0.0549)	(0.395)	(0.0971)	(0.376)
TobinQ	−0.00920	0.0871	−0.00577	0.225	−0.0372	0.212
	(0.0201)	(0.160)	(0.0158)	(0.216)	(0.0347)	(0.164)
CAPEX	−0.00381*	0.00119	−0.00442*	−0.00556	−0.00484*	−0.000569
	(0.00229)	(0.00727)	(0.00268)	(0.00968)	(0.00276)	(0.00418)
Constant	0.274***	0.541	0.298***	0.240	0.325**	0.142
	(0.0966)	(0.545)	(0.0943)	(0.716)	(0.154)	(0.533)
Observations	7237	3904	7237	3904	7237	3904
Number of id	1724	922	1724	922	1724	922

(Continues)

TABLE 7 | (Continued)

Variables	(1) Full sample ROA	(2) G7 ROA	(3) Full sample ROA	(4) G7 ROA	(5) Full sample ROA	(6) G7 ROA
Hansen-Test	0.123	0.156	0.128	0.198	0.231	0.235
AR(1)	0.009	0.003	0.000	0.050	0.000	0.007
AR(2)	0.120	0.150	0.214	0.167	0.174	0.090

Note: The table presents the results of GMM estimations testing the moderating effects of CCPI and stakeholder-level environmental attention (EcoRA and CAI) on the relationship between CO_2 emission reductions and firm performance. Statistical significance: ***$p<0.01$; **$p<0.05$;*$p<0.1$.

TABLE 8 | Granger causality Test.

Test	Coeff.	SE	F-stat	*p*	Reject 5%
ROA ← CO_2 Red	0.0107	0.0035	0.0025	0.0025	Yes
CO_2 Red ← ROA	−0.1560	0.1364	1.31	0.253	No

Note: The table reports the results of the Granger Causality Test examining the temporal relationship between CO_2 emission reductions and ROA. The test assesses whether past changes in CO_2 emissions predict future ROA, and whether past ROA predicts subsequent changes in emissions.

the adoption of a first-order lag structure, which strengthens the robustness of the empirical strategy.

5.3 | Robustness Check Hypothesis 2a/ Hypothesis 2b: GMM Estimations

Table 7 shows the results of the GMM estimation used to test Hypothesis 2a and Hypothesis 2b, addressing potential endogeneity concerns related to the interaction terms. Across all specifications, the coefficient on the lagged CO_2 reduction variable remains positive and statistically significant in most models, particularly in the G7 sample, providing additional support for the claim that firms that reduce emissions tend to be more profitable. These findings confirm the robustness of the positive link between corporate decarbonisation efforts and company profitability, reinforcing support for Hypothesis 1 and Hypothesis 1a even after controlling for dynamic endogeneity.

However, the interaction terms yielded limited evidence in support of Hypothesis 2a and Hypothesis 2b. Specifically, the interaction between CO_2 reduction and the CCPI (Inter1), tested in models GMM in (1) and GMM in (2), proved not to be statistically significant in either the full sample or the G7 sub-sample. This suggests that, on its own, climate policy stringency may not systematically amplify the financial benefits of emission reductions, thereby offering little support for Hypothesis 2a. As regards Hypothesis 2b, the evidence remains mixed. The interaction between CO_2 reduction and ECORA (Inter2) in models GMM in (3) and GMM in (4) was found to be positive but not statistically significant. In contrast, model GMM in (6) revealed a significant and negative interaction between CO_2 reduction and CAI (Inter3) in the G7 sub-sample, indicating that strong public attention to climate issues may reduce the financial benefits of emission reductions, possibly due to greater scrutiny or higher stakeholder expectations. Nonetheless, CAI on its own has a positive and weakly significant effect, suggesting some reputational or market value linked to public climate awareness. Overall, while the GMM confirms the positive effect of CO_2 reduction on firm performance, the moderating role of institutional and stakeholder-level factors appears limited. Only CAI shows a significant interaction in the G7 sub-sample, pointing to a nuanced and context-dependent influence of stakeholder pressure. Finally, diagnostic tests confirm the internal consistency of the models. As in the previous robustness check, the Hansen test supports the validity of the instrument set, particularly in the G7 specifications, while the Arellano–Bond statistics detect the expected first-order correlation but refute second-order serial correlation. This validates the use of the selected instruments and justifies the adoption of a first-order lag structure.

5.4 | Additional Analysis: Granger Causality Test

As complementary and additional analysis, we performed a Granger causality test to further assess the relationship between CO_2 reduction and firm profitability. The results, summarised in Table 8, show that CO_2 reduction at time t-1 has a positive and statistically significant effect on ROA at time t. This supports the notion that environmental improvements can lead to future financial gains. Conversely, past ROA does not significantly predict subsequent CO_2 reductions, indicating that firm profitability alone is not a driver of emissions reduction initiatives in this sample. These findings support a unidirectional causality from environmental to financial performance, reinforcing the interpretation that a firm's value can be enhanced over time by proactive CO_2 management, thereby confirming the strategic relevance of the latter.

6 | Conclusions, Limitations and Directions for Future Research

This study provides empirical evidence that corporate CO_2 abatement enhances a firm's profitability, with effects that are more pronounced and persistent in G7 economies. These results remain robust across alternative measures of emission reductions, model specifications, and dynamic estimations, lending support to the view that decarbonisation constitutes a value-creating capability rather than a mere compliance cost. The findings also indicate that the institutional and informational context plays a critical role: while national climate policy ambition shows limited influence on the abatement–performance link, stakeholder attention exerts a significant moderating effect, either amplifying or constraining the economic payoff depending on its nature and intensity. These results situate decarbonisation strategies within the broader risk–return framework and underscore the importance of credible disclosure and institutional quality in shaping private incentives to cut carbon.

From a theoretical standpoint, this research contributes to the NRBV by demonstrating that proactive emissions reduction generates competitive advantages not only through efficiency gains, but also by strengthening legitimacy and stakeholder trust, ultimately translating into greater financial outcomes. The study also enriches institutional theory by revealing that the information environment—captured through search-based attention—conditions the value realisation process to a greater extent than formal policy stringency alone, offering a novel perspective on how normative and cognitive pressures interact with corporate strategy. In doing so, it bridges the gap between institutional pressures and market responses, demonstrating that attention is a key mechanism through which sustainability efforts are priced.

Practical implications follow for managers, investors, and policymakers. For corporate decision-makers, our results highlight that decarbonisation should be integrated into core business strategy and communicated through credible, verifiable commitments in order to maximise reputational and financial benefits. For investors and lenders, realised abatement trajectories provide a valuable screening criterion for capital allocation, especially in markets in which public scrutiny is high. For regulators and standard-setters, the findings suggest that strengthening disclosure quality, assurance mechanisms, and enforcement may be more effective as regards aligning private incentives with climate objectives than simply raising policy targets.

As with any empirical study, this investigation has limitations that open avenues for future research. First, our analysis focuses on Scope 1–2 emissions; extending the framework to Scope 3 emissions would allow investigation of supply-chain decarbonisation effects. Second, search-based proxies for public attention, while informative, could be complemented with textual analyses of corporate reports, earnings calls, and media sentiment to capture information flows more precisely. Third, the 2019–2023 window coincides with significant macroeconomic and energy shocks; future studies might consider longer time spans or natural experiments to enhance causal identification. Finally, sectoral and governance heterogeneity, particularly in hard-to-abate industries, warrants further exploration to investigate factors such as the role of executive incentives, board structures and financing conditions in reinforcing or diminishing the profitability of climate action.

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