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Corporate GHG Emissions and Financial Performance: A Cross-Country Panel Analysis of Sectoral Heterogeneity in Advanced and Emerging Economies

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Abstract

As the urgency to address climate change intensifies, understanding the financial implications of corporate greenhouse gas (GHG) emission reduction has become critical. This study examines the relationship between emission reductions and corporate financial performance (CFP) in 468 companies across advanced and emerging market economies (EMEs) from 2010 to 2022. Using a standardized emissions score to mitigate inconsistencies in greenhouse gas (GHG) reporting, we analyze how sectoral and regional dynamics influence financial outcomes using a panel fixed-effects model. The results are mixed: emission reductions are positively associated with CFP in advanced economies and low-emitting sectors. However, companies in high-emitting industries experience a negative relationship between emission reductions and CFP. The findings underscore the need for policies and corporate strategies calibrated by sector and country development status, as the emissions–profitability relationship varies across contexts.

Keywords: climate change; ESG; firm performance; greenhouse gas emissions

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1. Introduction

The intensifying effects of climate change have heightened pressures on firms to improve their environmental performance. Investors, regulators, and consumers increasingly expect companies to reduce their greenhouse gas (GHG) emissions and to disclose their progress transparently. Consequently, many companies have adopted environmentally sustainable practices as part of their comprehensive environmental, social, and governance (ESG) strategies. Unfortunately, existing research has yet to provide a consistent answer on whether such actions improve or come at the expense of corporate financial performance (CFP), as understood as a firm's ability to generate profits from its operational activities. Such results likely reflect heterogeneity across countries and sectors as well as inconsistencies in reporting, cautioning against assuming a uniform emissions–profitability relationship.

Previous studies in the literature on the relationship between environmental performance and CFP have been mixed. Some studies suggest that this relationship is positive, indicating that firms with lower emissions tend to experience better financial performance. For instance, a recent meta-analysis by Galama and Scholtens (2021) found that companies with lower emissions tend to have superior financial outcomes, particularly in countries with stringent carbon policies. Conversely, other research indicates a negative or neutral relationship. For example, Matsumura et al. (2014) found that changes in GHG emissions did not consistently affect financial performance, suggesting that the benefits of reducing emissions may not be universally applicable. These conflicting findings can be attributed to various factors, including differences in research methodologies, periods analyzed, and the specific financial performance indicators used. Additionally, industry-specific characteristics and regional regulatory environments can contribute to the variability in results. Moreover, cross-country and cross-sector heterogeneity add an extra layer of complexity.

Rather than treating these mixed findings as inconclusive, we interpret them as evidence of systematic heterogeneity: short-run financial consequences are not uniform across countries or sectors. We posit that the sign and magnitude of the association between environmental and financial performance vary with countries' development level (advanced vs. emerging economies) and sectoral emission intensity (high vs. low), reflecting differences in regulatory frameworks, transition costs, disclosure credibility, and institutional conditions. Accordingly, this paper examines whether—and how—the emissions–profitability association differs by development level and sectoral intensity. To ensure cross-firm comparability, we rely on the LSEG–Refinitiv's Greenhouse Gas Emission Score (GHG-E), a standardized emissions–performance metric that mitigates inconsistencies in corporate reporting (see Ibishova et al., 2024). Using this measure allows us to assess how the relationship between higher GHG-E (better emission performance) and corporate financial performance varies across countries and sectors.

Utilizing a panel of 468 publicly listed firms from 16 countries and 18 industrial sectors spanning the period 2010 to 2022, this work examines the association between GHG emission reduction and four measures of corporate financial performance: return on assets (ROA), earnings before interest, taxes, depreciation, and amortization (EBITDA) margin, operating margin and net margin (Matsumura et al., 2014; Trumpp & Guenther, 2017). We selected these indicators because they reflect different perspectives on the income statement, enabling a consistent assessment of financial outcomes across firms and over time. Although market-based measures, such as Tobin's Q or stock returns (Guerrero-Escobar et al., 2025), are also used in the literature (albeit less frequently), we focus on accounting-based indicators, primarily capturing short- to medium-term realized profitability, due to their broader data availability across both advanced and emerging economies in our sample. The goal is to move beyond a single average association and identify context-dependent relationships.

This work contributes to the literature in three ways. First, it disaggregates results by development group and sectoral emission intensity, uncovering differences in how a reduction in GHG emissions relates to financial performance. Second, it compares across four profitability indicators, each reflecting different points along the income statement. Third, it documents associational patterns that are robust to granular fixed effects—including firm and time effects, as well as country-by-year and sector-by-year in robustness checks—thereby providing a context-dependent map of where emission performance coincides with stronger or weaker profitability. To our knowledge, there are no other works that perform this type of disaggregation of results. While some works analyze the difference between developed and developing countries, they do not extend the analysis to different sectors (Manrique & Martí-Ballester, 2017). In turn, other studies separate by industry but do not consider different profitability measures or examine the differences between countries' development levels (Ibishova et al., 2024).

The results reveal meaningful patterns. On average, higher GHG-E scores—indicating more substantial reductions in emissions—are associated with improved financial performance. However, these findings vary significantly by country development level and sectoral emission intensity. Firms in advanced economies and low-emitting sectors typically experience an improvement in CFP due to emission reductions, reflecting the benefits of robust regulatory frameworks and lower transition costs. In contrast, the results are mixed for firms in high-emitting sectors, particularly those domiciled in EMEs (for example, firms in the Food, Beverages, and Tobacco sectors gain from reducing emissions).

Lastly, companies in the Chemicals industry observe a deterioration of CFP. This negative relationship may be caused by substantial financial and operational investments required to adopt environmentally friendly practices (Nichita et al., 2021). These findings underscore the need for sector-specific strategies and suggest that policies promoting emission reduction should consider the economic and industrial contexts of targeted firms. Policymakers need sector-specific evidence to calibrate climate policy and transition support by development level, while firms must align decarbonization strategies with operating constraints and financing conditions that could differ across high and low-emitting sectors.

The remainder of the paper is organized as follows. Section 2 reviews the literature in three strands (positive, negative, and context-dependent evidence) and presents a brief theoretical framework with associational hypotheses. Section 3 describes the data, sample construction (2010–2022), variables, and the empirical strategy, emphasizing a fixed-effects design and a non-causal interpretation. Section 4 reports results, including heterogeneity by development level and sectoral emission intensity. Section 5 provides robustness checks. Section 6 concludes.

2. Literature Review

Much literature addresses the relationship between companies' environmental performance, often measured through GHG emissions or broader ESG indicators, and CFP. Nevertheless, the results in such literature are sometimes inconsistent. While a majority of studies suggest a positive and statistically significant relationship, some suggest a negative linkage, and others yield inconclusive results. Hence, we organize the literature into three strands: studies reporting *positive* associations between environmental and financial performance, studies finding *negative* associations, and *inconclusive or context-dependent* evidence.

2.1. Positive Associations

A substantial set of studies documents a *positive association* between environmental performance (including GHG outcomes) and corporate financial performance, often attributed to operational efficiencies, risk mitigation, and stakeholder or signaling channels (e.g., meta-analytic evidence).

From those that find a positive relationship, we have Fujii et al. (2013) and Gnanaweera and Kunori (2016) who studied the case of the manufacturing sector in Japan. Both works conclude that mitigating GHG emissions has a positive influence on CFP. In turn, by analyzing a sample of several companies in the United States, Eccles et al. (2014) find that companies that adopted sustainable policies were able to financially outperform companies that did not implement them over the long run. Similarly, using a broader sample of US-listed companies, Khan et al. (2017) conclude that a positive and statistically significant association exists between material ESG indicators, particularly those related to climate efforts, and stock returns.

Beyond the study of specific industries and countries, another strand of the literature employs the meta-analysis approach. For instance, by analyzing over 2000 studies, the work of Gunnar Friede and Bassen (2015) suggests a positive correlation between ESG strategies and financial performance in advanced economies. In a similar analysis of 34 studies, Galama and Scholtens (2021) state that companies that reduce GHG emissions exhibit an improvement of CFP, and that this result is more notable for companies operating in countries with strict environmental policies.

Additionally, using a more extensive dataset of companies, Manrique and Martí-Ballester (2017) also find that the implementation of environmentally friendly strategies is associated with better financial performance in both developed and developing economies, but that this association is more pronounced for companies domiciled in developing countries. The authors attribute this result to the timing of implementation, stating that in developing countries, companies are at the earliest stages, which may require fewer resources than companies in developed economies in the final implementation phases that require elevated amounts of investment.

Recent work in advanced economies is broadly consistent with these patterns; for example, Ibishova et al. (2024) find that reductions in carbon emissions are associated with higher ROA/ROE profitability among listed. In the UK, reporting quality strengthens these relationships by reducing information frictions and supporting credible signaling to investors and lenders (Al-Shaer & Hussainey, 2022).

2.2. Negative Associations

Another strand finds a *negative association*, particularly where abatement entails material transition costs, process redesign, or compliance burdens—effects that may be more salient in high-emitting sectors or highly monitored markets.

Utilizing the stakeholders and government pressure framework to explain the relationship between CO_2 intensity and return on assets of listed companies in Indonesia, Rokhmawati et al. (2015) find a negative relationship between GHG reduction and manufacturing firms' financial performance and state that such a result is due to the lack of reasonable financial incentives to reduce GHG emissions and low penalties for increasing them. The authors also argue that firms must pay attention to stakeholders' interests to preserve their value and be more successful in the long run. Firms that fail to contribute to social development despite stakeholder pressure can damage their reputation.

An alternative explanation for the negative relationship between GHG emissions and financial performance is that green investments may reflect only higher costs, triggering decreased earnings and a lower market value of firms (Nichita et al., 2021). Several empirical works support that argument (García-Sánchez & Prado-Lorenzo, 2012; Trumpp & Guenther, 2017). Notably, Wang et al. (2014) find a negative relation between GHG emissions and Tobin's q for 69 Australian public firms listed on the ASX200 during 2010. However, they argue that this result was, in a sense, predictable because of several reasons attached to features of the Australian economy, such as historical heavy reliance on the metal and mining industries, strong lobby groups from emission-intensive industries, more concern for economic development than environmental deterioration, weak climate change regulations, and less stimulus for companies to improve their environmental performance. To reverse this mechanism, Wang et al. (2014) suggest more efficient market mechanisms, such as carbon taxes—although the long-term consequences of such tax imposition must be studied.

Recently, Oestreich and Tsiakas (2024) document that for companies domiciled in advanced economies, higher emissions are linked to lower profitability, consistent with market penalties for carbon intensity, as well as tighter investor scrutiny and potential price or financing penalties for carbon intensity. These patterns are aligned with short-run margin pressures when abatement requires significant capital expenditures and process redesign.

2.3. Inconclusive or Context-Dependent Evidence

A third group of studies reports *mixed or context-dependent* results, with sign and magnitude varying by sector, metric, disclosure regime, and institutional environment.

Budiharjo (2019) test the hypothesis that environmental performance affects the value of firms listed in the Indonesia Stock Exchange for the 2015–2017 period. They find a positive relation, but it is not statistically significant, contributing to the inconclusive literature about this topic for emerging markets. Other authors, such as Moore (2001), also find inconclusive results for advanced economies. In particular, they use several metrics for a small sample of UK firms, such as age (measured from the year of incorporation), size (measured by average turnover), and gearing, and estimate mixed relationships between these variables and social performance. They only find the expected coefficient sign (positive) and statistically significant for the firm's size. In turn, Kim and Li (2021) states that methodological differences, different ESG metrics, variations in the time horizon, and sample selection can also contribute to contrasting results. Berg et al. (2022) attributes the divergence of results to the different ESG and GHG metrics available, which are not directly comparable, and produce complications for the empirical analysis linking GHG reduction and CFP.

Lastly, a growing strand emphasizes that results are context-dependent, varying with disclosure regimes, monitoring intensity, and data integration. Disclosure and reporting practices shape observed associations in the UK and Australia (Al-Shaer & Hussainey, 2022; Miklosik et al., 2021), while linked emissions–finance datasets in Canada illustrate how market monitoring and transition risk visibility condition these relationships (Ackman et al., 2023).

2.4. Theoretical Framework and Hypotheses

The results listed above suggest that the emissions–profitability relationship is not uniform but *systematically heterogeneous* along sectoral and institutional lines. Hence, we develop a mechanism-based framework that yields *associational* predictions (not causal claims) about how firms' emission performance relates to accounting-based profitability, taking into account countries' development level and sectoral emission intensity.

In high-emitting activities, near-term abatement typically requires capital expenditures, process redesign, and potential disruptions to output. Under tighter oversight and pricing in advanced economies, these costs can compress margins in the short term, even if the long-term benefits may outweigh them. Empirically, evidence from developed markets links higher emissions to lower profitability, consistent with market penalties for carbon intensity, see Oestreich and Tsiakas (2024).

Where stakeholders value decarbonization and information frictions are lower, credible emissions improvements can reduce perceived transition risk and support pricing power or financing access. Disclosure quality and sustainability governance—including formal sustainability committees and enterprise risk management (ERM) processes that explicitly address ESG risks—can strengthen these associations by enhancing credibility, comparability, and execution. For instance, sustainability committee structures are associated with better reporting and performance linkages (Shah et al., 2024b), and ERM has been linked to broader "green growth" outcomes in the Malaysian oil and gas context (Shah et al., 2024a).

Regulatory stringency, carbon pricing, disclosure rules, and investor preferences differ across advanced and EMEs, shifting both the benefits of signaling and the costs of transition. For companies operating in advanced economies, reductions in emissions are associated with higher profitability for listed firms, as noted by (Ibishova et al., 2024). In EMEs, institutional frictions and financing constraints can dampen or delay these channels.

Hypotheses (associational). Given these mechanisms, we posit the following hypothesis:

H1. Higher GHG-E (better emission performance) is *positively associated* with accounting-based profitability.

H2. Higher GHG-E is *negatively associated* with accounting-based profitability in the short term, reflecting salient transition and compliance costs.

H3. Associations are *mixed*: positive where signaling credibility and access to transition finance dominate; non-positive where abatement costs and operational frictions dominate.

3. Data and Methodology

This study examines the association between greenhouse gas emission reductions and corporate financial performance, using distinct profitability measures that capture various dimensions of a firm's performance. The analysis utilizes annual data spanning the period 2010–2022, covering companies domiciled in ten advanced economies, including Canada, France, Germany, Ireland, Netherlands, New Zealand, Norway, Switzerland, the United Kingdom, and the United States, as well as six emerging market economies, namely Brazil, Chile, India, Mexico, Poland, and South Africa. The dataset encompasses 18 industrial sectors, as detailed in Appendix A.

We begin in 2010 because it is the earliest year with systematic and comparable GHG-E coverage in our LSEG extract, and firm-level emissions reporting becomes sufficiently dense from that date to support cross-country analysis. Our analysis ends in 2022 because it is the last complete financial year with broad availability of GHG-E scores and audited financial statements across the included countries at the time of extraction.

3.1. CFP Measures

The analysis begins by using the return on assets (ROA) ratio, the most common measure of CFP in the related literature. ROA is a profitability indicator that, according to Zabri et al. (2016), better reflects a firm's efficiency in allocating resources. Specifically, ROA reflects how a firm generates income from its assets, and it is defined as:

$$ROA = \frac{Net\ Income}{Average\ Total\ Assets} \times 100 \quad (1)$$

Despite its popularity in empirical research, ROA has some drawbacks. For instance, the indicator is sensitive to accounting conventions and the book value of assets, which may differ across industries and countries due to diverse depreciation methods or capital intensity. These limitations can play a crucial role when comparing ROA across companies in sectors with high fixed capital requirements or those undergoing structural changes to mitigate climate transition risks (Kölbel et al., 2020). For example, a firm known to be a high GHG emitter may see a fall in the value of its assets due to the introduction of new climate-friendly policies or technological obsolescence.

To mitigate such drawbacks, we follow Richard et al. (2009) and incorporate three additional measures. The first is the EBITDA margin (EBITDA stands for earnings before interest, taxes, depreciation, and amortization), a profitability indicator that captures how much earnings a company generates before paying financing and cash charges. It is defined as:

$$EBITDA_{mg} = \frac{EBITDA}{Total\ Revenue} \times 100 \quad (2)$$

The main advantage of using the EBITDA margin is that this ratio is not affected by the firm's capital structure, fiscal framework, or the book value of assets. However, given that it does not consider a firm's debt level, it may result in an overly optimistic view of its health, which can be problematic for highly leveraged companies.

Second, we use the operating margin, which indicates how much profit a company makes per dollar of sales after paying for all operating expenses. This measure is defined as:

$$Op_{mg} = \frac{Operating\ Income}{Total\ Revenue} \times 100 \tag{3}$$

where operating income equals income less operating costs (the cost of goods sold, administration expenses, selling and marketing, R&D, depreciation, and other expenses). A company with a high operating margin is considered to have less financial risk.

Third, the net margin indicates the percentage of profit a company generates from its revenue. This measure is considered the most comprehensive indicator of profitability because it accounts for all the company's operations. It is defined as follows:

$$Net_{mg} = \frac{Net\ Income}{Total\ Revenue} \times 100 \tag{4}$$

where net income equals operating income less interest and taxes.

Note that each of these measures comes from different levels of a firm's income statement, allowing for a more robust analysis of the effects of GHG reduction on corporate financial performance (Bouten et al., 2011). Companies' annual financial income statements were obtained from LSEG–Refinitiv.

Although all four indicators used in this study are accounting-based, they differ in their placement along the income statement and, consequently, in their interpretative focus. Among them, ROA is the most widely used in the literature and is particularly relevant for capturing the firm's short- to medium-term operational efficiency (Busch & Hoffmann, 2011; Matsumura et al., 2014). In contrast to market-based measures such as Tobin's Q, which reflect investors' long-term expectations, ROA and other profitability ratios rely on realized performance as reported in financial statements. As a result, the analysis presented here primarily reflects near-term financial outcomes associated with GHG emission reductions. The use of multiple profitability indicators allows us to assess the consistency of this relationship across several operational layers, while acknowledging that future research with richer market-based data could explore long-term value effects more directly (Galama & Scholtens, 2021).

3.2. GHG Emissions Indicator

Almost all listed companies provide information regarding their GHG emissions in their ESG or sustainability reports. However, they employ diverse frameworks and methodologies to measure and disclose their emissions, leading to inconsistencies and difficulties in data comparability.

The Climate Disclosure Standards Board (CDSB) has emphasized the importance of consistency in corporate climate change disclosure to enhance the reliability of reported information. Specifically, the CDSB has highlighted that consistent reporting practices enable better assessment and comparison of climate-related risks and opportunities at the corporate and broader market levels (Climate Disclosure Standards Board, 2020). In its guidance, the CDSB advocates integrating climate-related financial disclosures into mainstream corporate reporting, ensuring alignment with international frameworks such as the Task Force on Climate-Related Financial Disclosures (TCFD). This approach aims to harmonize methodologies, minimize discrepancies, and promote a transparent understanding of a company's environmental impact.

Along the same lines, the Science-Based Targets Initiative (SBTi) has underscored the significance of consistent and transparent disclosure of GHG emissions and progress toward emission reduction targets. The initiative acknowledges that inconsistent reporting practices can lead to discrepancies, complicating the assessment of climate-related risks and opportunities across companies. To address these challenges, the SBTi guides financial institutions in managing climate risks and maximizing opportunities for emission reduction (Climate Disclosure Standards Board, 2023).

In general, the absence of uniform reporting standards leads to discrepancies that complicate empirical analyses. Variations in the scope of reported emissions (e.g., Scope 1, 2, or 3) and differences in measurement techniques can lead to significant disparities in reported data. This lack of comparability hampers the ability of researchers and investors to accurately assess the financial implications of a firm's environmental performance.

Therefore, it is essential to have a measure of emissions constructed under the same framework, allowing for a direct and more straightforward comparison across companies, sectors, and jurisdictions. Hence, we rely on ESG Environmental Pillar Score data from LSEG–Refinitiv to measure firms' GHG emissions, focusing specifically on the "emission reduction score" (GHG-E) component. This indicator aggregates firm-level data across 22 dimensions, providing a standardized metric that facilitates cross-company comparisons. The GHG-E score ranges from 0 to 100, with higher values indicating greater reductions in emissions. In other words, a higher GHG-E score implies that a firm has reduced its emissions considerably.

3.3. Control Variables

We introduce as controls some firm characteristics that may influence CFP, such as firm size, growth, leverage, and capital intensity (see Matsumura et al., 2014; Busch et al., 2020). Firm size is measured as the natural logarithm of total assets. Firm growth is the annual percentage change in total sales (see Delmas et al., 2015). We use the ratio of long-term debt to total capital as a leverage indicator and capital turnover (representing the efficiency with which firms generate revenue from working capital) as a proxy for capital intensity. These variables are lagged to mitigate endogeneity concerns, except for growth, computed as a year-over-year percentage change.

Note that using total assets as a proxy for firm size may raise doubts about the possibility that our analysis of ROA may artificially create a relationship between these two variables. We will attempt to mitigate this problem by incorporating firms' size with a lag into our estimations (see the next section). Although this strategy may not fully solve the problem, we consider it necessary to include size, given its importance in corporate financial performance (see (Muhammad et al., 2021) and (Yadav et al., 2021), for example). In contrast, excluding it may create an omitted variable problem, which could be more severe in this case.

3.4. Sample Selection

All listed firms report different CFP measures in their financial reports. ROA is the most common profitability indicator in these reports, but some firms do not report the information required to calculate the Op_{Mg}, Net_{Mg}, and $EBITDA_{Mg}$.

The biggest constraint on our sample of firms stems from the GHG emissions data, particularly when selecting firms domiciled in EMEs, as they have only begun providing ESG and sustainability reports regularly in recent years. We implemented two procedures to maximize the number of firms with ESG data. First, we look for companies that adhered to the Paris Agreement in our selected countries. Then, we searched for them on the LSEG Platform, selecting only those with at least four years of GHG-E data. Unfortunately, this selection method drastically reduced the number of listed firms in the SBTi dataset. The final dataset comprises an unbalanced panel of 468 companies, resulting in 6595 firm-year observations; see Table 1.

Table 1. Sample of companies per country.

Country	Number of Firms	Classification
Brazil	14	Emerging
Canada	17	Advanced
Chile	4	Emerging
France	46	Advanced
Germany	45	Advanced
India	41	Emerging
Ireland	10	Advanced
Mexico	5	Emerging
Netherlands	11	Advanced
Poland	3	Emerging
S. Africa	10	Emerging
Switzerland	25	Advanced
UK	97	Advanced
US	185	Advanced

Source: LSEG–Refinitiv.

3.5. Summary Statistics

Table 2 presents the summary statistics for the variables above. The overall mean in return on assets (ROA) is 1.83 percent, with a standard deviation of 1 percent, indicating moderate variation across firms. The primary independent variable, GHG-E score, has a mean of 67.08 and a standard deviation of 25.14, reflecting significant differences in emission reduction efforts across firms. In contrast, firm size, measured as the natural logarithm of total assets, shows a mean of 23.34 with a relatively narrow standard deviation of 1.91.

Firm growth, represented by the annual percentage change in total sales, exhibits considerable variability, with a mean of 10.65 percent and a standard deviation of 231.56 percent. This high variability underscores the diverse growth trajectories of firms in the sample. Leverage, defined as the ratio of long-term debt to total capital, has a mean of 155.97 percent and a standard deviation of 1572.85 percent. Capital intensity, which measures revenue efficiency relative to working capital, is relatively low on average, with a mean of 0.06 and a standard deviation of 37.54, indicating high variability across firms.

Contrasting across groups, columns three and four in Table 2 show that companies domiciled in advanced economies have a slightly higher return on assets (ROA) than companies in emerging market economies (EMEs). We also observe greater dispersion in advanced economies (with a standard deviation of 1.02) compared to emerging market economies (EMEs) (with a standard deviation of 0.88). Similar results are observed when examining the summary statistics for EBITDA, operating, and income margins.

Distinguished by sectoral emission intensity, the last two columns in Table 2 illustrate that companies in high-emitting industries have a lower ROA (1.79 percent) than those in the low-emitting ones (1.85 percent). Still, they have a similar level of dispersion (standard deviation of 1).[1] In contrast, high-emitter companies not only appear more profitable when examining other CFP measures (EBITDA, operating, and income margins) but also exhibit greater variability than companies in the low-emitter industries.

Although the differences in mean and standard deviation are of small magnitude, these still point to heterogeneous financial conditions across countries' development levels and sectoral emission intensity, which supports the need for using diverse profitability indicators.

Table 2. Summary statistics.

	All	Advanced Economies	EMEs	Highest Emitters	Lowest Emitters
ROA					
Mean	1.83	1.84	1.79	1.79	1.85
Std. Dev.	(1.00)	(1.02)	(0.88)	(1.00)	(1.00)
EBITDA Margin					
Mean	2.86	2.88	2.80	2.91	2.83
Std. Dev.	(0.78)	(0.78)	(0.74)	(0.78)	(0.77)
Operating Margin					
Mean	2.42	2.44	2.33	2.46	2.40
Std. Dev.	(0.97)	(0.97)	(0.95)	(0.99)	(0.95)
Net Margin					
Mean	2.06	2.09	1.91	2.13	2.01
Std. Dev.	(1.07)	(1.07)	(1.04)	(1.07)	(1.06)
GHG Emissions Score					
Mean	67.08	66.80	68.37	67.32	66.92
Std. Dev.	(25.14)	(25.43)	(23.72)	(25.50)	(24.92)
Total Assets (size)					
Mean	557.04	660.03	79.46	110.98	846.91
Std. Dev.	(9496.97)	(10,467.49)	(287.04)	(347.34)	(12,187.17)
Growth					
Mean	10.65	11.37	7.42	14.89	7.93
Std. Dev.	(231.56)	(255.80)	(23.82)	(366.42)	(40.65)
Leverage					
Mean	155.97	166.83	107.20	207.31	122.69
Std. Dev.	(1572.85)	(1737.74)	(139.74)	(2477.72)	(309.94)
Capital Intensity					
Mean	0.06	−0.04	0.51	0.66	−0.31
Std. Dev.	(37.54)	(41.17)	(12.33)	(58.71)	(12.05)
Observations	6595	5429	1166	2590	4005

Note: Total assets are expressed in billions of US dollars.

3.6. Model Specification

Given the structure of our data, we use a panel fixed-effects approach to analyze the association between GHG emissions and CFP.[2] In particular, we estimate:

$$Y_{i,t} = \alpha_i + \lambda_t + \beta * X_{i,t-1} + \delta * W_{i,t-1} + \epsilon_{i,t} \quad (5)$$

$Y_{i,t}$ represents one of our selected CFP measures for firm i at time t; $X_{i,t-1}$ represents the explanatory variable of interest: the emission reduction score. Note that this variable is introduced with a lag to avoid double causality following Lewandowski (2017); W is a matrix of control variables described in the previous section. All these variables are also lagged but firm growth, since, by definition, it already includes information from the prior year. α and λ represent firm and time-fixed effects, respectively, and ϵ is the error term. To account for the elevated variation in growth and leverage reported in Table 2, we exclude the most extreme 1 percent values.[3]

An issue that sometimes arises when having cross-country data is cross-sectional dependence. In this case, such an issue may occur due to the interconnectedness of neighboring countries in our sample, resulting in biased estimates (on the one hand, we have those from Europe, and on the other, Canada, Mexico, and the US). Hence, we test for weak cross-sectional dependence using Pesaran (2015). The advantage of this test is that it can be implemented not only for large N- and large T-dimensional panels but also for large

N-, small T-unbalanced panels, as is the present case. The test provides a CD statistic of 4.707 with a p-value of 0.000, leading to the rejection of the null hypothesis that the errors are weakly cross-sectional dependent. Thus, we estimate Equation (1) using firm-based, cluster-robust standard errors.

It is important to note that the analysis presented here is not intended to identify causal effects, but rather to estimate the relationship between environmental and financial performance. Although the primary explanatory variable, GHG-E, is introduced with a one-period lag to mitigate concerns about simultaneity and contemporaneous correlation, this approach does not eliminate the possibility of endogeneity. In particular, it may be the case that more profitable firms are better positioned to invest in emission-reducing technologies or sustainability initiatives, thereby improving their GHG-E scores. The lag structure serves to clarify the temporal ordering between variables, but it is not employed as an instrumental variable in the econometric sense. Accordingly, the results should be interpreted as conditional associations rather than causal impacts.

4. Results

This section illustrates the relationship, if any, between firms' GHG emissions, as proxied by GHG-E, and corporate financial performance. First, we estimate our model using ROA, which is the most common profitability measure in the literature, and extend the analysis to the other three selected measures described in the previous section (EBITDA, Operating, and Net margins). These measures will allow us to account for differences in capital structure, taxation, and accounting methods that could influence our results.

Second, we assess the economic significance of our results by implementing a simple benchmarking exercise that compares the predicted change in CFP associated with variation in the GHG-E. Lastly, we explore heterogeneity between firms domiciled in advanced and emerging economies, as well as across industrial sectors.

4.1. Estimation Results Across CFP Measures

Table 3 shows that a one-unit increase in GHG-E, which implies a reduction in emissions, is positively related to all our selected profitability measures, with the estimated parameters statistically significantly different from zero. In particular, a one-unit rise in GHG-E is related to an increase of 0.003 percentage points in ROA, 0.0022 in operating margin, and 0.0020 percentage points in net margin.

Also, note that a one percent increase in firms' size is associated with a negative coefficient on three of four CFP measures. Such a negative association may look unexpected since firms' size is measured as total assets, and a firm with ample assets is considered more profitable. Nevertheless, Becker-Blease et al. (2010) states that it is unclear why the relationship between firm size and profitability is necessarily positive. Moreover, such authors find that there can be a negative relationship between size and profitability.

Lastly, the firms' growth coefficient is statistically significant and positive for all CFP measures. In turn, an increase in capital intensity is associated with a statistically significant and positive increase in ROA, Operating, and Net margins.

Despite being statistically significant, the magnitude of the estimated coefficients suggests that the relationship between reducing GHG emissions and CFP is, at the very least, modest. Nevertheless, if we take into account the variations in GHG-E score, such an effect may be non-negligible. For instance, consider a hypothetical benchmark company domiciled in an advanced economy, with total assets of one billion USD and a baseline ROA of 1.83 percent, which corresponds to the sample mean (see Table 2). If this company can raise its GHG-E score by one standard deviation (25.14 points), its ROA could increase from 1.83 to 1.905 percent. Then, taking the estimated coefficient reported in Table 3, such a change will translate into a net income gain of roughly USD 655 thousand per year, assuming, of course, that the firm keeps a constant asset base.

Table 3. Regression analysis of GHG emission reduction on CFP.

	(1) ROA	(2) EBITDA Margin	(3) Operating Margin	(4) Net Margin
GHG Emissions Score (t − 1)	0.0030 ***	0.0011 **	0.0022 ***	0.0020 **
	(0.0010)	(0.0005)	(0.0008)	(0.0010)
Firm size (t − 1)	−0.4937 ***	0.0255	−0.1519 ***	−0.2436 ***
	(0.0684)	(0.0373)	(0.0586)	(0.0618)
Growth	0.0072 ***	0.0024 ***	0.0053 ***	0.0039 ***
	(0.0011)	(0.0006)	(0.0008)	(0.0011)
Leverage (t − 1)	−0.0003	0.0000	−0.0002	−0.0003
	(0.0002)	(0.0001)	(0.0002)	(0.0002)
Capital intensity (t − 1)	0.0006 ***	0.0004	0.0026 ***	0.0026 ***
	(0.0002)	(0.0004)	(0.0007)	(0.0007)
Observations	4438	4785	4574	4395
R-squared	0.102	0.035	0.073	0.068
Adjusted R-squared	0.10	0.03	0.07	0.06
Hausman χ^2	184.897	47.682	52.899	75.978
Hausman p-value	0.000	0.000	0.000	0.000

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects included but not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

In the same fashion, the EBITDA margin will increase by approximately 0.0277 percentage points, the operating margin by 0.0528 percentage points, and the net margin by 0.0503 percentage points. This higher profitability can be particularly important for firms competing in industries where small margin gains could result in significant strategic advantages. For example, the opportunity to enter the green bonds and loans markets, or to gain the confidence of investors and clients.

4.2. Differences by Economic Development: Advanced Economies vs EMEs

While the previous subsection illustrates that reducing GHG emissions has a positive effect on CFP, it is essential to examine whether such results are consistent across firms domiciled in countries with varying levels of economic development. The rationale for this comparison is that companies operating in advanced economies typically face more strict regulation, are subject to rigorous disclosure standards, and are more exposed to ESG-oriented capital markets, which may strengthen the relationship between climate-friendly strategies and CFP. In turn, firms domiciled in EMEs face weaker regulations and less developed financial markets, which may influence how cutting GHG emissions translates into financial performance.

Tables 4 and 5 show that an increase in the GHG-E score is positively related to the CFP of firms operating in both advanced and emerging economies (the estimated parameter is positive and statistically significant). In the case of those in advanced economies, a reduction in GHG emissions is associated with an increase of 0.0022 percentage points in ROA, 0.0012 in EBITDA margin, and 0.0018 in Operating margin. Still, the estimated coefficient is not statistically significant for net margin (Table 4). In turn, the relationship for companies in EMEs suggests an increase in ROA of 0.0058 percentage points, 0.0039 pp in Operating, and 0.006 pp in Net margin (Table 5). Lastly, note that across specifications, Hausman tests reject the random effects in favor of the fixed-effects model.

Table 4. Regression analysis of GHG emission reduction on CFP in advanced economies.

	(1) ROA	(2) EBITDA Margin	(3) Operating Margin	(4) Net Margin
GHG Emissions Score (t − 1)	0.0026 **	0.0012 **	0.0020 **	0.0012
	(0.0011)	(0.0005)	(0.0008)	(0.0010)
Firm size (t − 1)	−0.5398 ***	0.0287	−0.1683 ***	−0.2619 ***
	(0.0738)	(0.0406)	(0.0592)	(0.0650)
Growth	0.0075 ***	0.0025 ***	0.0057 ***	0.0043 ***
	(0.0012)	(0.0007)	(0.0009)	(0.0012)
Leverage (t − 1)	−0.0004	0.0001	−0.0002	−0.0005 *
	(0.0002)	(0.0001)	(0.0002)	(0.0002)
Capital intensity (t − 1)	0.0007 ***	0.0005	0.0027 ***	0.0027 ***
	(0.0001)	(0.0004)	(0.0006)	(0.0006)
Observations	3611	3888	3720	3567
R-squared	0.124	0.045	0.09	0.091
Adjusted R-squared	0.11	0.04	0.08	0.08
Hausman χ^2	164.008	21.714	54.137	75.384
Hausman *p*-value	0.000	0.025	0.000	0.000

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects included but not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5. Regression analysis of GHG emission reduction on CFP in emerging economies.

	(1) ROA	(2) EBITDA Margin	(3) Operating Margin	(4) Net Margin
GHG Emissions Score (t − 1)	0.0056 **	0.0009	0.0037 *	0.0060 **
	(0.0023)	(0.0013)	(0.0020)	(0.0026)
Firm size (t − 1)	−0.2979 **	0.0013	−0.0601	−0.1457
	(0.1496)	(0.0893)	(0.1679)	(0.1627)
Growth	0.0057 **	0.0021 *	0.0039 **	0.0025
	(0.0025)	(0.0011)	(0.0019)	(0.0023)
Leverage (t − 1)	0.0001	−0.0002	−0.0005	0.0001
	(0.0007)	(0.0004)	(0.0008)	(0.0006)
Capital intensity (t − 1)	−0.0036	−0.0009	−0.0030	−0.0049 **
	(0.0026)	(0.0007)	(0.0026)	(0.0021)
Observations	827	897	854	828
R-squared	0.12	0.066	0.045	0.043
Adjusted R-squared	0.11	0.06	0.04	0.04
Hausman χ^2	49.702	23.128	20.590	25.203
Hausman *p*-value	0.014	0.027	0.027	0.026

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects included but not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.3. High vs. Low Emitters

The above suggests that although a positive relationship between cutting back GHG emissions and CFP appears to exist, it is essential to dig deeper to analyze whether these findings are observed across all sectors. Hence, we re-estimate our model, described in Equation (1), but add another layer to the analysis by separating firms into high- and low-emitter sectors.

The results show that GHG-E does not have a statistically significant relationship with ROA for companies in advanced economies operating in high-emission sectors (Table 6 column 1). In contrast, high-emitting firms operating in EMEs can increase financial performance by lowering GHG emissions. In particular, a one-unit increase in GHG-E is associated with a 1 percent rise in ROA (Table 6 column 2). Lastly, companies in low-emitting sectors localized in advanced economies exhibit a stronger positive relationship between cutting GHG emissions and CFP than firms in EMEs (Table 6 Columns 3 and 4).

Table 6. Regression analysis of GHG emission reduction on ROA by sector type.

	High Emitters		Low Emitters	
	(1) Advanced	(2) EMEs	(3) Advanced	(4) EMEs
GHG Emissions Score (t − 1)	0.0013	0.0101 ***	0.0033 ***	−0.0013
	(0.0020)	(0.0027)	(0.0013)	(0.0028)
Firm size (t − 1)	−0.5125 ***	−0.3208	−0.5628 ***	−0.3129 *
	(0.1281)	(0.2338)	(0.0899)	(0.1832)
Growth	0.0068 ***	0.0091 **	0.0078 ***	0.0024
	(0.0018)	(0.0038)	(0.0015)	(0.0034)
Leverage (t − 1)	−0.0005	−0.0005	−0.0003	0.0010
	(0.0003)	(0.0006)	(0.0004)	(0.0011)
Capital intensity (t − 1)	0.0008 ***	−0.0024	−0.0014	−0.0097
	(0.0001)	(0.0025)	(0.0012)	(0.0062)
R-squared	0.114	0.168	0.112	0.150
Adjusted R-squared	0.101	0.140	0.107	0.107
Observations	1191	494	2420	333
Groups	131	50	250	36

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects included but not reported. Sectors known to be higher GHG emitters are: Chemicals; Construction and Building; Food, Beverages and Tobacco; Oil Gas and Mining; Transportation; and Utilities. Low GHG emitter sectors are: Computing; Forest and Paper Products; Healthcare and Pharmaceuticals; Hotels, Rest. and Leisure; Retail; Telecommunications; Textiles; and Wholesale. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

When measuring CFP by the EBITDA margin, we find that a higher GHG-E score is not statistically related to the financial performance of companies in high-emission sectors (Table 7, Columns 1 and 2). However, similar to our results using ROA, reducing GHG emissions has a positive and statistically significant association for companies from advanced economies in low-emitting sectors. In particular, a one-unit increase in GHG-E is related to a 0.15 percent rise in EBITDA_{mg}, while no significant effect is found for firms in EMEs (Table 7, Columns 3 and 4).

In the case of Operating margin, a higher GHG-E implies an increase of 0.7 percent in Opt_{Mg} for companies in high-emitting sectors located in EMEs and a rise of 0.2 percent for firms in low-emitting sectors domiciled in advanced economies (Table 8, Columns 1 to 4). Similarly, when using Net margin, the only statistically significant relationships are observed for companies in emerging market economies in high-emitter sectors (Table 9, Columns 1 to 4).

Given the above, it is crucial to determine why companies from advanced economies in high GHG-emitting sectors do not benefit from cutting emissions while those from EMEs do. Therefore, we analyze each industry separately. The results, using only ROA as a CFP measure, show that an increase in GHG-E is positively associated with the ROA of firms in the Food, Beverage, and Tobacco industries. In contrast, for companies in the Chemical and Transportation sectors, a higher GHG-E is associated with a lower ROA (Table 10).[4] A possible explanation for this negative sign is that reducing emissions could represent significant financial and operational challenges. For example, companies may need to either upgrade their existing production technology or invest in new one, which could generate substantial costs and disruptions to their production process, putting pressure on companies' balance sheets and deteriorating profitability in the short to medium term.

Table 7. Regression analysis of GHG emission reduction on EBITDA margin by sector type.

	High Emitters		Low Emitters	
	(1) Advanced	**(2) EMEs**	**(3) Advanced**	**(4) EMEs**
GHG Emissions Score (t − 1)	0.0007 (0.0008)	0.0012 (0.0016)	0.0015 ** (0.0006)	0.0000 (0.0016)
Firm size (t − 1)	0.0373 (0.0863)	−0.0389 (0.1310)	0.0265 (0.0412)	0.0674 (0.1200)
Growth	0.0034 ** (0.0015)	0.0038 ** (0.0015)	0.0021 *** (0.0008)	0.0001 (0.0015)
Leverage (t − 1)	0.0002 (0.0001)	0.0001 (0.0003)	−0.0000 (0.0002)	−0.0005 (0.0006)
Capital intensity (t − 1)	0.0007 ** (0.0004)	−0.0009 (0.0008)	−0.0008 (0.0007)	−0.0016 (0.0023)
R-squared	0.046	0.033	0.063	0.049
Adjusted R-squared	0.034	0.003	0.058	0.005
Observations	1293	535	2595	362
Groups	131	50	251	36

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects included but not reported. Sectors known to be higher GHG emitters are: Chemicals; Construction and Building; Food, Beverages and Tobacco; Oil Gas and Mining; Transportation; and Utilities. Low GHG emitter sectors are: Computing; Forest and Paper Products; Healthcare and Pharmaceuticals; Hotels, Rest. and Leisure; Retail; Telecommunications; Textiles; and Wholesale. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8. Regression analysis of GHG emission reduction on operating margin by sector type.

	High Emitters		Low Emitters	
	(1) Advanced	**(2) EMEs**	**(3) Advanced**	**(4) EMEs**
GHG Emissions Score (t − 1)	0.0012 (0.0013)	0.0068 ** (0.0027)	0.0024 ** (0.0009)	0.0002 (0.0023)
Firm size (t − 1)	−0.1539 (0.1179)	−0.0298 (0.2763)	−0.1745 *** (0.0660)	0.0221 (0.1925)
Growth	0.0067 *** (0.0018)	0.0079 *** (0.0026)	0.0055 *** (0.0011)	−0.0002 (0.0024)
Leverage (t − 1)	0.0002 (0.0002)	0.0005 (0.0005)	−0.0004 (0.0004)	−0.0012 (0.0013)
Capital intensity (t − 1)	0.0029 *** (0.0006)	−0.0026 (0.0031)	0.0002 (0.0012)	−0.0059 * (0.0034)
R-squared	0.159	0.099	0.051	0.078
Adjusted R-squared	0.148	0.069	0.044	0.034
Observations	1234	506	2486	348
Groups	131	50	250	36

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects included but not reported. Sectors known to be higher GHG emitters are: Chemicals; Construction and Building; Food, Beverages and Tobacco; Oil, Gas and Mining; Transportation; and Utilities. Low GHG emitter sectors are: Computing; Forest and Paper Products; Healthcare and Pharmaceuticals; Hotels, Rest. and Leisure; Retail; Telecommunications; Textiles; and Wholesale. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 9. Regression analysis of GHG emission reduction on net margin by sector type.

	High Emitters		Low Emitters	
	(1) Advanced	**(2) EMEs**	**(3) Advanced**	**(4) EMEs**
GHG Emissions Score (t − 1)	0.0015 (0.0017)	0.0111 *** (0.0033)	0.0010 (0.0013)	−0.0013 (0.0029)
Firm size (t − 1)	−0.4067 *** (0.1318)	−0.1354 (0.2510)	−0.1891 *** (0.0675)	−0.2288 (0.1874)
Growth	0.0040 *** (0.0014)	0.0071 ** (0.0032)	0.0046 *** (0.0017)	−0.0023 (0.0036)
Leverage (t − 1)	−0.0001 (0.0003)	−0.0007 (0.0006)	−0.0007 ** (0.0003)	0.0013 (0.0009)
Capital intensity (t − 1)	0.0028 *** (0.0005)	−0.0052 ** (0.0024)	−0.0016 (0.0013)	−0.0040 (0.0054)
R-squared	0.180	0.123	0.057	0.081
Adjusted R-squared	0.169	0.094	0.050	0.034
Observations	1177	494	2390	334
Groups	131	50	250	36

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects included but not reported. Sectors known to be higher GHG emitters are: Chemicals; Construction and Building; Food, Beverages and Tobacco; Oil, Gas and Mining; Transportation; and Utilities. Low GHG emitter sectors are: Computing; Forest and Paper Products; Healthcare and Pharmaceuticals; Hotels, Rest. and Leisure; Retail; Telecommunications; Textiles; and Wholesale. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 10. Regression analysis of GHG emission reduction on ROA for firms of advanced economies in higher-emitter sectors.

	(1) Chemicals	**(2) Construction**	**(3) Food, Beverages and Tobacco**	**(4) Transport**	**(5) Utilities**
GHG Emissions Score (t − 1)	−0.0127 ** (0.0050)	−0.0005 (0.0026)	0.0121 ** (0.0047)	−0.0038 * (0.0021)	0.0051 (0.0047)
Firm size (t − 1)	0.2804 * (0.1543)	−0.4856 (0.3067)	−0.4889 ** (0.1997)	−0.9599 *** (0.2335)	−0.1069 (0.2369)
Growth	0.0056 (0.0061)	0.0044 (0.0035)	0.0114 *** (0.0024)	0.0090 ** (0.0033)	0.0024 (0.0019)
Leverage (t − 1)	−0.0020 (0.0022)	−0.0015 * (0.0007)	−0.0004 (0.0005)	0.0001 (0.0005)	0.0003 (0.0009)
Capital intensity (t − 1)	0.0015 *** (0.0003)	0.0002 (0.0005)	0.0033 (0.0026)	0.0015 (0.0026)	0.0011 (0.0095)
R-squared	0.362	0.199	0.180	0.228	0.217
Adjusted R-squared	0.238	0.156	0.141	0.184	0.099
Observations	99	315	349	295	123
Groups	11	33	38	34	13

Note: Bootstrap cluster errors included (see MacKinnon et al., 2023). Country and time fixed effects are included but not reported. Results for the Oil, Gas, and Mining sector are omitted due to a very small number of observations. p-values in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Concerning firms located in EMEs, a one-unit increase in GHG-E is positively associated with the ROA of companies in the Food, Beverage, and Tobacco and Utilities sectors. At the same time, a higher GHG-E has a negative relationship with the financial performance of companies in the Chemicals sector. For the other sectors, the association is not statistically significant (Table 11).

Table 11. Regression analysis of GHG emission reduction on ROA for firms of EMEs in higher-emitter sectors.

	(1) Chemicals	(2) Construction and Building	(3) Food, Beverages and Tobacco	(4) Oil, Gas and Mining	(5) Transport	(6) Utilities
GHG Emissions Score (t − 1)	−0.0183 ***	0.0061	0.0151 **	−0.0006	0.0015	0.0226 **
	(0.0045)	(0.0039)	(0.0064)	(0.0100)	(0.0099)	(0.0066)
Firm size (t − 1)	−3.2635	−0.4603	0.1894	−0.1415	−0.5686	1.2129
	(1.9768)	(0.3799)	(0.2691)	(0.3367)	(0.3685)	(0.6733)
Growth	0.0029	0.0024	0.0214 **	0.0100 *	0.0115	0.0263 ***
	(0.0149)	(0.0053)	(0.0073)	(0.0049)	(0.0128)	(0.0027)
Leverage (t − 1)	−0.0027 **	0.0022	−0.0014	−0.0009	0.0015	0.0045
	(0.0009)	(0.0023)	(0.0017)	(0.0009)	(0.0015)	(0.0038)
Capital intensity (t − 1)	−0.0032	−0.0050	−0.0132	−0.0051	0.0044	0.0278
	(0.0022)	(0.0046)	(0.0143)	(0.0060)	(0.0079)	(0.0452)
R-squared	0.395	0.337	0.333	0.309	0.304	0.664
Adjusted R-squared	0.209	0.215	0.191	0.149	0.168	0.465
Observations	69	104	92	86	99	44
Groups	8	10	10	9	9	4

Note: Bootstrap cluster errors included (see MacKinnon et al., 2023). Country and time fixed effects are included but not reported. p-values in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The strong positive association observed for high-emitting sectors in emerging economies appears to be a more novel result. Manrique and Martí-Ballester (2017) attribute such a positive relationship between environmental performance and CFP in developing economies to the timing of implementation of climate-friendly actions. According to these authors, in developing economies, firms must be at the earliest stages of reducing emissions. At that point, the required investment amount is not as high as it is for companies domiciled in advanced economies, which are likely to be in later phases.

5. Robustness Tests

We assess the robustness of our results by re-estimating our baseline model, excluding fixed effects, and then introducing firm and year fixed effects. Also, we sequentially introduce country and country-by-year fixed effects. These additional specifications will enable us to account for time-invariant heterogeneity across sectors and countries, as well as to consider the implementation of different environmental policies across countries that may also vary over time.

Table 12 shows that the coefficient of GHG-E score remains positive and statistically significant different from zero in all specifications, from column (2) onward, and stable at a value of 0.0026. Such results suggest that the relationship between a reduction in emissions and CFP is robust to the introduction of more granular fixed effects. It is essential to highlight that when time and fixed effects are omitted, the coefficient of GHG-E becomes statistically insignificant, which underscores the importance of considering firm and country characteristics, as well as time-varying unobserved factors.

Table 13 shows the results of a similar exercise for the EBITDA margin. Here we see that, across all specifications, the estimated parameter of the GHG-E score is positive and statistically significantly different from zero. Although its magnitude falls as more comprehensive fixed effects are included, that parameter stabilizes at 0.011 from column (3) onward. The robustness of this result supports the interpretation that environmental improvements may enhance core operating cash flows, rather than being solely a function of broader firm characteristics or macroeconomic context.

Table 12. Fixed-effects robustness for ROA regressions.

	(1)	(2)	(3)	(4)
GHG Emissions Score (t − 1)	−0.0010 (0.3784)	0.0035 *** (0.0003)	0.0026 *** (0.0084)	0.0026 *** (0.0092)
Firm size (t − 1)	−0.0774 *** (0.0012)	−0.4553 *** (0.0000)	−0.5523 *** (0.0000)	−0.5694 *** (0.0000)
Growth	0.0000 (0.6937)	0.0000 (0.2446)	0.0000 (0.4617)	0.0000 (0.3548)
Leverage (t − 1)	−0.0000 (0.1837)	0.0000 (0.8755)	0.0000 (0.9152)	0.0000 (0.4704)
Capital intensity (t − 1)	0.0004 *** (0.0029)	0.0004 *** (0.0000)	0.0004 *** (0.0017)	0.0004 *** (0.0026)
R-squared	0.0282	0.0547	0.5993	0.6144
Adjusted R-squared	0.0271	0.0537	0.5517	0.5484
Firm FE	No	Yes	Yes	Yes
Time FE	No	No	Yes	Yes
Country FE	No	No	No	Yes
Country×Time FE	No	No	No	Yes

Note: Firm-based cluster-robust standard errors in parentheses. p-values in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 13. Fixed-effects robustness for EBITDA margin regressions.

	(1)	(2)	(3)	(4)
GHG Emissions Score (t − 1)	0.0020 * (0.0811)	0.0015 *** (0.0008)	0.0011 ** (0.0169)	0.0011 ** (0.0119)
Firm size (t − 1)	0.0446 ** (0.0239)	0.0496 * (0.0569)	0.0109 (0.7674)	0.0093 (0.7949)
Growth	−0.0000 (0.9751)	0.0000 *** (0.0005)	0.0000 ** (0.0265)	0.0000 ** (0.0336)
Leverage (t − 1)	−0.0000 (0.2858)	−0.0000 (0.7948)	−0.0000 (0.8030)	0.0000 (0.7393)
Capital intensity (t − 1)	0.0005 (0.1718)	0.0005 * (0.0544)	0.0004 * (0.0939)	0.0004 (0.1102)
R-squared	0.0209	0.0158	0.8758	0.8822
Adjusted R-squared	0.0199	0.0148	0.8621	0.8637
Firm FE	No	Yes	Yes	Yes
Time FE	No	No	Yes	Yes
Country FE	No	No	No	Yes
Country×Time FE	No	No	No	Yes

Note: Firm-based cluster-robust standard errors in parentheses. p-values in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Repeating the analysis for the operating margin, Table 14 shows that, as observed in the previous case, the estimated coefficient of the GHG-E score is statistically significantly different from zero in all specifications. The coefficient converges to approximately 0.0021 in the preferred specifications (Columns 3–5), suggesting a durable association between emission performance and operational efficiency. Compared to the EBITDA results, the slightly larger coefficient here implies that emission performance may also be linked to improvements in cost structure or asset utilization, beyond direct cash flow effects.

Table 14. Fixed-effects robustness for operating margin regressions.

	(1)	(2)	(3)	(4)
GHG Emissions Score (t − 1)	0.0025 * (0.0716)	0.0025 *** (0.0008)	0.0021 *** (0.0052)	0.0021 *** (0.0037)
Firm size (t − 1)	0.0296 (0.2190)	−0.1435 *** (0.0004)	−0.1937 *** (0.0012)	−0.2011 *** (0.0005)
Growth	0.0001 *** (0.0000)	0.0000 *** (0.0030)	0.0000 * (0.0557)	0.0000 * (0.0575)
Leverage (t − 1)	−0.0000 ** (0.0152)	−0.0000 * (0.0592)	−0.0000 ** (0.0264)	−0.0000 (0.4084)
Capital intensity (t − 1)	0.0022 *** (0.0001)	0.0023 *** (0.0000)	0.0023 *** (0.0000)	0.0022 *** (0.0000)
R-squared	0.0180	0.0433	0.7468	0.7575
Adjusted R-squared	0.0169	0.0423	0.7176	0.7174
Firm FE	No	Yes	Yes	Yes
Time FE	No	No	Yes	Yes
Country FE	No	No	No	Yes
Country×Time FE	No	No	No	Yes

Note: Firm-based cluster-robust standard errors in parentheses. p-values in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Lastly, Table 15 contains the results of our robustness exercise for the net margin indicator. The estimated coefficient remains positive and statistically significant across all models, ranging from 0.0033 in the model with no fixed or time effects to 0.0020 in the preferred specifications. While the magnitude declines slightly with additional fixed effects, the stability and significance of the results reinforce the association between better environmental performance and stronger bottom-line profitability.

Table 15. Fixed-effects robustness for net margin regressions.

	(1)	(2)	(3)	(4)
GHG Emissions Score (t − 1)	0.0033 ** (0.0309)	0.0031 *** (0.0015)	0.0020 * (0.0504)	0.0020 ** (0.0436)
Firm size (t − 1)	0.0131 (0.5983)	−0.1413 *** (0.0024)	−0.2847 *** (0.0000)	−0.2947 *** (0.0000)
Growth	0.0001 *** (0.0000)	0.0000 (0.1556)	0.0000 (0.7160)	0.0000 (0.6438)
Leverage (t − 1)	−0.0000 (0.1671)	0.0000 (0.8023)	0.0000 (0.8553)	0.0000 (0.7112)
Capital intensity (t − 1)	0.0024 *** (0.0001)	0.0023 *** (0.0000)	0.0023 *** (0.0000)	0.0023 *** (0.0000)
R-squared	0.0168	0.0367	0.7245	0.7363
Adjusted R-squared	0.0157	0.0357	0.6914	0.6907
Firm FE	No	Yes	Yes	Yes
Time FE	No	No	Yes	Yes
Country FE	No	No	No	Yes
Country×Time FE	No	No	No	Yes

Note: Firm-based cluster-robust standard errors in parentheses. p-values in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6. Conclusions

The relationship between greenhouse gas (GHG) emissions and corporate financial performance has been a significant concern in recent years, notably since governments and companies agreed to the terms of the Paris Agreement. As a result, several firms have begun to adopt climate-friendly technology and processes. Nevertheless, it has not been clear whether these strategies provide positive financial outcomes. Moreover, inconsistent reporting practices and variations in GHG emissions metrics may also contribute to divergent results in the literature.

The study provides a context-dependent map of the emissions–profitability association, showing how its sign and strength vary systematically with development level and sectoral emission intensity, using standardized GHG-E and multiple profitability measures, and confirming robustness under granular fixed effects. The estimates are associational, but the comparative lens clarifies where accounting profitability tends to be stronger or weaker in relation to improved emission performance.

The results suggest that the financial benefits of reducing GHG emissions are highly contingent on both sectoral characteristics and national development level. In advanced economies and low-emitting sectors, firms generally experience positive financial outcomes. By contrast, in high-emitting industries, a negative association is found in advanced economies, whereas the results are mixed in emerging market economies. This pattern accords with prior work reporting small positive ESG-CFP links (e.g., Gunnar Friede & Bassen, 2015) and developed-economy findings where emission reductions coincide with higher profitability (Ibishova et al., 2024), alongside studies documenting lower profitability for more carbon-intensive firms (Oestreich & Tsiakas, 2024) and the conditioning role of disclosure quality and sustainability governance (Ackman et al., 2023; Al-Shaer & Hussainey, 2022; Miklosik et al., 2021; Shah et al., 2024b).

Within EMEs, positive associations are most evident in Food, Beverages, and Tobacco and Utilities. At the same time, energy- and resource-intensive industries (e.g., Chemicals, Oil, Gas, and Mining) tend to show a statistically significant negative relationship, likely due to the substantial operational and financial challenges involved in emissions mitigation. Notably, however, we also observe a strong positive association between environmental performance and profitability in high-emitting sectors of some emerging markets. This may be the result of companies in EMEs being in the earliest stages of adopting climate-friendly strategies. Overall, the findings are robust to the inclusion of more granular fixed effects. Lastly, results pertain to the firms and jurisdictions covered in our LSEG–Refinitiv extract (2010–2022); while the associations are robust across specifications, they should be interpreted within this coverage and as non-causal.

Climate policy, corporate strategy, and investment screening should be tailored to specific sectors and development stages. Transition support is most relevant where short-run abatement costs are salient; credible disclosure and governance can strengthen information channels where stakeholders value decarbonization. Future studies could use plausibly exogenous climate policy changes—such as the introduction of a carbon tax, expansions of emissions-trading schemes, or mandated disclosure/assurance—to identify how information and institutional channels operate. Complementarily, project-level data on specific abatement investments (e.g., efficiency retrofits, fuel switching) and their costs would permit direct tests of the transition-cost channel. Finally, results pertain to the firms and jurisdictions covered in our LSEG–Refinitiv extract for 2010–2022; while the associations are robust across specifications, they should be interpreted within this coverage and as non-causal.

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Appendix A. Number of Firms by Sector

Table A1. Number of Firms in High Emitters Sectors.

	Total	Advanced Economies	EMEs
Chemicals	20	12	8
Construction and Building	49	39	10
Food, Beverages and Tobacco	52	42	10
Oil, Gas and Mining	12	3	9
Transportation	49	40	9
Utilities	20	14	6

Source: LSEG–Refinitiv and Environment and Climate Change Canada (2023).

Table A2. Number of Firms in Low Emitters Sectors.

	Total	Advanced Economies	EMEs
Computing	77	68	9
Consumer Durables and Household	20	20	0
Containers and packaging	8	7	1
Electrical Equipment and Machinery	46	44	2
Forest and Paper Products	12	10	2
Healthcare and pharmaceuticals	32	27	5
Hotels, Restaurants and Leisure	24	23	1
Media	10	10	0
Retail	30	25	5
Telecommunications	15	8	7
Textiles	26	21	5
Wholesale	11	10	1

Source: LSEG-Refintiv and Environment and Climate Change Canada (2023).

Appendix B. GHG Emission Reduction in Low-Emitting Sectors

Examining the results for the low-emitter sectors, we find that GHG-E has no statistically significant effect on companies' return on assets (ROA) for companies in EMEs. However, the results may be affected by the small sample of firms within such sectors (see Appendix A). In turn, we did find a statistically significant association between GHG-E and ROA for companies operating in low-emitting sectors domiciled in advanced economies, as shown in Table 8. However, a sector-by-sector analysis shows no statistically significant relation between emission reduction and ROA for companies in low-emitting sectors from advanced economies (Tables A3 and A4). Hence, the result in Table 8 can be attributed to the larger sample size resulting from grouping companies across all these sectors.

Table A3. Regression analysis of GHG emission reduction on ROA for firms of advanced economies in low-emitter sectors.

	(1) Computing	(2) Consumer Durables	(3) Containers and Packaging	(4) Electrical Eq. and Machinery	(5) Forest and Paper Products	(6) Healthcare and Pharmaceuticals
GHG Emissions Score (t − 1)	0.0033	−0.0011	0.0076	0.0047	−0.0104	0.0009
	(0.0023)	(0.0057)	(0.0057)	(0.0031)	(0.0067)	(0.0047)
Firm size (t − 1)	−0.6986 ***	0.2670	−1.0356 **	−0.6203 ***	−0.3514	−1.0783 ***
	(0.1477)	(0.3619)	(0.3373)	(0.1930)	(0.3967)	(0.2182)
Growth	0.0067 ***	0.0189 ***	0.0145	0.0053	0.0051	0.0071
	(0.0022)	(0.0053)	(0.0088)	(0.0036)	(0.0030)	(0.0047)
Leverage (t − 1)	−0.0001	−0.0010 ***	−0.0019	−0.0001	−0.0005	0.0005
	(0.0003)	(0.0003)	(0.0014)	(0.0003)	(0.0022)	(0.0004)
Capital intensity (t − 1)	−0.0040 **	0.0250 **	0.0029	−0.0009	−0.0020	0.0046
	(0.0016)	(0.0101)	(0.0045)	(0.0021)	(0.0018)	(0.0069)
R-squared	0.213	0.204	0.432	0.188	0.346	0.204
Adjusted R-squared	0.189	0.137	0.204	0.151	0.204	0.148
Observations	548	205	57	368	91	242
Groups	59	20	6	39	9	25

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects included but not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A4. Regression analysis of GHG emission reduction on ROA for firms of advanced economies in low-emitter sectors.

	(1) Hotels, Rest and Leisure	(2) Media	(3) Retail	(4) Telecommunications	(5) Textiles	(6) Wholesale
GHG Emissions Score (t − 1)	0.0032	0.0035	0.0053	0.0062	0.0083	−0.0055
	(0.0045)	(0.0064)	(0.0046)	(0.0089)	(0.0049)	(0.0029)
Firm size (t − 1)	−0.4637	0.1029	−0.2682	−0.0683	−1.0616 ***	0.3209
	(0.2822)	(0.5679)	(0.1820)	(0.3075)	(0.3405)	(0.3727)
Growth	0.0022 **	0.0095	0.0094 **	0.0022	0.0066 *	0.0047 **
	(0.0010)	(0.0093)	(0.0043)	(0.0024)	(0.0036)	(0.0013)
Leverage (t − 1)	−0.0012 ***	−0.0009	0.0006	0.0002 **	0.0004	−0.0125 **
	(0.0003)	(0.0005)	(0.0004)	(0.0001)	(0.0003)	(0.0040)
Capital intensity (t − 1)	−0.0036 ***	−0.0011	0.0053	0.0084 **	−0.0043	−0.0116
	(0.0005)	(0.0041)	(0.0057)	(0.0028)	(0.0032)	(0.0089)
R-squared	0.218	0.187	0.139	0.500	0.188	0.541
Adjusted R-squared	0.162	0.054	0.083	0.347	0.116	0.416
Observations	238	115	262	69	197	76
Groups	23	10	25	7	21	7

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects included but not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix C. Results Including the Most Extreme 1% Values in Growth and Leverage

Table A5. Regression analysis of GHG emission reduction on EBITDA margin by sector type.

	(1) ROA	(2) EBITDA Margin	(3) Operating Margin	(4) Net Margin
GHG Emissions Score (t − 1)	0.0026 ***	0.0011 **	0.0021 ***	0.0020 *
	(0.0010)	(0.0005)	(0.0007)	(0.0010)
Firm size (t − 1)	−0.5523 ***	0.0109	−0.1937 ***	−0.2847 ***
	(0.0644)	(0.0368)	(0.0593)	(0.0653)
Growth	0.0000	0.0000 **	0.0000 *	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Leverage (t − 1)	0.0000	−0.0000	−0.0000 **	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Capital intensity (t − 1)	0.0004 ***	0.0004 *	0.0023 ***	0.0023 ***
	(0.0001)	(0.0003)	(0.0005)	(0.0005)
R-squared	0.081	0.023	0.057	0.063
Adjusted R-squared	0.078	0.020	0.054	0.060
Observations	4523	4886	4665	4479
Groups	468	469	468	468

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects included but not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A6. Regression analysis of GHG emission reduction on CFP in advanced and emerging economies.

	Advanced Economies				EMEs			
	(1) ROA	(2) EBITDA Margin	(3) Operating Margin	(4) Net Margin	(5) ROA	(6) EBITDA Margin	(7) Operating Margin	(8) Net Margin
GHG Emissions Score (t − 1)	0.0022 **	0.0012 **	0.0018 **	0.0012	0.0058 **	0.0010	0.0039 *	0.0060 **
	(0.0011)	(0.0005)	(0.0008)	(0.0011)	(0.0023)	(0.0013)	(0.0020)	(0.0026)
Firm size (t − 1)	−0.6117 ***	0.0123	−0.2178 ***	−0.3184 ***	−0.2966 *	−0.0051	−0.0695	−0.1306
	(0.0678)	(0.0404)	(0.0609)	(0.0700)	(0.1532)	(0.0877)	(0.1663)	(0.1691)
Growth	0.0000	0.0000 ***	0.0000 **	0.0000	0.0046 **	0.0006	0.0017	0.0005
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0022)	(0.0011)	(0.0016)	(0.0021)
Leverage (t − 1)	0.0000	−0.0000	−0.0000 **	0.0000	0.0001	−0.0000	−0.0002	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0004)	(0.0002)	(0.0004)	(0.0004)
Capital intensity (t − 1)	0.0004 ***	0.0005 **	0.0023 ***	0.0024 ***	−0.0038	−0.0010	−0.0033	−0.0055 ***
	(0.0001)	(0.0002)	(0.0004)	(0.0004)	(0.0025)	(0.0008)	(0.0025)	(0.0020)
R-squared	0.087	0.033	0.069	0.082	0.120	0.012	0.046	0.053
Adjusted R-squared	0.083	0.030	0.065	0.078	0.103	−0.006	0.028	0.035
Observations	3686	3975	3800	3641	837	911	865	838
Groups	382	383	382	382	86	86	86	86

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects included but not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A7. Regression analysis of GHG emission reduction on ROA by sector type.

	High Emitters		Low Emitters	
	(1) Advanced	**(2) EMEs**	**(3) Advanced**	**(4) EMEs**
GHG Emissions Score (t − 1)	0.0007	0.0104 ***	0.0031 **	−0.0012
	(0.0020)	(0.0027)	(0.0013)	(0.0028)
Firm size (t − 1)	−0.5830 ***	−0.3445	−0.6049 ***	−0.3085 *
	(0.1169)	(0.2355)	(0.0836)	(0.1793)
Growth	−0.0000	0.0066 **	0.0050 ***	0.0024
	(0.0000)	(0.0030)	(0.0012)	(0.0034)
Leverage (t − 1)	−0.0000 **	−0.0002	0.0001	0.0008
	(0.0000)	(0.0004)	(0.0001)	(0.0006)
Capital intensity (t − 1)	0.0005 ***	−0.0024	−0.0024 **	−0.0095
	(0.0001)	(0.0024)	(0.0012)	(0.0061)
R-squared	0.097	0.160	0.109	0.152
Adjusted R-squared	0.085	0.132	0.103	0.109
Observations	1218	502	2,468	335
Groups	131	50	251	36

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects included but not reported. Sectors known to be higher GHG emitters are: Chemicals; Construction and Building; Food, Beverages and Tobacco; Oil, Gas and Mining; Transportation; and Utilities. Low GHG emitter sectors are: Computing; Forest and Paper Products; Healthcare and Pharmaceuticals; Hotels, Rest. and Leisure; Retail; Telecommunications; Textiles; and Wholesale. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A8. Regression analysis of GHG emission reduction on EBITDA margin by sector type.

	High Emitters		Low Emitters	
	(1) Advanced	**(2) EMEs**	**(3) Advanced**	**(4) EMEs**
GHG Emissions Score (t − 1)	0.0008	0.0013	0.0013 **	−0.0001
	(0.0007)	(0.0016)	(0.0006)	(0.0016)
Firm size (t − 1)	0.0181	−0.0644	0.0124	0.0628
	(0.0902)	(0.1333)	(0.0389)	(0.1171)
Growth	0.0000 ***	0.0014	0.0003	−0.0004
	(0.0000)	(0.0016)	(0.0005)	(0.0014)
Leverage (t − 1)	−0.0000 **	−0.0000	0.0000	−0.0002
	(0.0000)	(0.0002)	(0.0000)	(0.0004)
Capital intensity (t − 1)	0.0007 ***	−0.0007	−0.0006	−0.0021
	(0.0002)	(0.0008)	(0.0005)	(0.0020)
R-squared	0.021	0.014	0.055	0.046
Adjusted R-squared	0.009	−0.015	0.049	0.002
Observations	1326	544	2649	367
Groups	131	50	252	36

Note: Firm-based cluster-robust standard errors in parentheses. Country and time fixed effects are included but not reported. Sectors known to be higher GHG emitters are: Chemicals; Construction and Building; Food, Beverages and Tobacco; Oil, Gas and Mining; Transportation; and Utilities. Low GHG emitter sectors are: Computing; Forest and Paper Products; Healthcare and Pharmaceuticals; Hotels, Rest. and Leisure; Retail; Telecommunications; Textiles; and Wholesale. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Notes

1. Highest emitters sectors are Chemicals, Construction and building, Food, beverages and tobacco, Oil, Gas and Mining, Transportation, and Utilities. Lower emitters are Computing; Consumer Durables; Containers and Packaging; Electrical Equipment and Machinery; Forest and Paper Products; Healthcare and Pharmaceuticals; Hotels, Restaurants and Leisure; Media, Professional Services; Real Estate, Retail; Specialized Consumer Services; Telecommunications; Trading Companies and Distributors, and

Textiles see Environment and Climate Change Canada (2023). Although the source provides this classification in the Canadian context, it reflects broadly recognized sectoral differences in emission intensity and is used here for cross-country comparisons.

2 The Hausman test contrasting fixed vs. random effects favors the former with a Chi-squared statistic of 49.87 and *p*-value 0.0001.

3 Appendix C shows that our results remain the same both with and without these observations.

4 Note that there are no estimation results for companies domiciled in advanced economies operating in the Oil, Gas, and Mining sector given that there are not enough observations to perform the estimation, we have only two such firms in our data.

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