Navigating the Green Path: Unveiling the Financial Impact of Green Management

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Abstract

This study examines the impact of green management practices on corporate financial performance using a unique panel dataset of 12,503 firm-year observations across 48 countries. We show that firms with stronger green management - measured by the Green Management Z-Score (GMZ) - tend to have better financial performance, as captured by Return on Assets (ROA). One standard deviation increase in the green management score is associated with a 4,6 percentage points increase in ROA. An instrumental variable (IV) approach with country-level carbon regulation and robustness checks with Return on Equity (ROE) and alternative green management measures further support our findings. However, the financial benefits of green management are not uniform. There is significant heterogeneity across sectors and regions: green management yields greater financial benefits in low-carbon-intensive sectors and high-income countries but is weaker in high-carbon-intensive sectors and low- or middle-income regions. Notably, while green management improves operational efficiency, its negative effect on Tobin's Q suggests that market valuations may not fully internalize the long-term advantages. These findings highlight the strategic value of green management for financial success and offer valuable insights for corporate decision-makers and policymakers navigating the transition to sustainable business practices.

1. Introduction

The escalating urgency of climate change is putting businesses under increasing pressure to adopt environmentally sustainable practices. Consequently, many companies are integrating green

management as a key managerial approach for addressing environmental concerns while also possibly gaining a competitive advantage. Accordingly, companies must develop green transition strategies that enable them to identify and leverage sustainable resources, creating value for the public and fostering green competitive advantages (Nassar and Strielkowski 2022a).

Green management can be costly as companies have to make decisions (operative and investment) that incur expenses. The profitability of these economic decisions are complicated by the aspect that environmental concerns of companies have two facets — the environmental impact of their business and the financial impact of their environmental-related activities and how society responds to them.[1] While corporate activities that alleviate environmental harm reduce the size of externalities (social costs), they may not be reflected in the companies' costs, a form of market failure. Hence, the companies may not immediately reap the financial benefits of green management. Over time, however, governments may introduce mechanisms (e.g. regulations, environmental taxes, subsidies etc.) that are deteriorate (improve) the financial performance of those companies that have adverse (beneficial) environmental impact. According to this view, there will be a time lag between the short-term costs of green management and the longer-term financial benefits, highlighting the importance of examining both the short and longer run financial impacts in empirical studies of green management.

On the other hand, green management strategies may improve competitive advantage, which may improve green management's financial benefits also in the short run. Therefore, one would expect the association between green management and financial performance to be ambiguous. The extant

[1] This is also being implemented in law. The newly adopted EU Corporate Sustainability Reporting Directive (CSRD) requires that companies that have to report according to CSRD have do carry out a double materiality analysis (DMA) that covers both the impact of the companies' activities on society (Impact Materiality, including environmental impact), as well has how sustainability factors (e.g. taxes, regulation, etc.) will impact the companies financially (Financial Materiality).

academic literature mirrors this ambivalence. While a substantial body of studies find a positive association between green management and financial performance (Molina-Azorin et al. 2009), there are several studies that do not find such significant relationships or that it is negative (Lankoski 2008; Lioui and Sharma 2012a; Molina-Azorin et al. 2009; Septiavin et al. 2023; Trumpp et al. 2015). Moreover, there are some limitations to the previous studies, such as focusing on short time frames, single industries, or specific countries. These limitations reduce the potential for making general inferences about the financial benefits of green management.

Our paper addresses these gaps in the literature by investigating both the short- and long-term relationship between green management and financial performance, as well as investigating the importance of some key contexts of companies, such as which sector they belong to and the economic status of the country where they are located. Contextual factors such as national culture, stringency of environmental regulation, and economic development can influence green management practices (Chen et al., 2018). Furthermore, green management costs may be different across sectors. In some sectors such as manufacturing and oil and gas, costs may be substantially higher than in other sectors.

Using a unique dataset of 12,503 firm-year observations across 48 countries, including high-income and low- or middle-income countries, over 10 years, we find that green management positively impacts corporate financial performance, as reflected by improvements in return on assets (ROA). Robustness checks with other financial performance measures, such as return on equity (ROE) and alternative green management measures, further confirm this relationship. However, endogeneity concerns may arise due to reverse causality - firms with stronger financial performance may have more resources to invest in green management initiatives. Additionally, omitted variable bias could mislead the estimated relationship if unobserved factors, such as

company culture or industry-specific trends, simultaneously influence both green management practices and financial performance. To address these issues, we employ an instrumental variable (IV) approach, using country-level carbon regulation as an instrument for green management. The IV analysis confirms a positive causal effect, indicating that corporate commitment to sustainability not only supports environmental goals but also enhances profitability. Thus, our findings imply that implementing green management practices can enhance corporate financial performance.

Furthermore, we find that the financial impact of green management varies substantially across sectors and countries, highlighting the importance of understanding the business context in which the companies belong. The positive relationship between green management and financial performance is substantially stronger in high-income than in low-income countries, possibly because high-income countries offer more supportive regulatory environments, stronger sustainability infrastructure, and greater stakeholder pressure to adopt green management practices. We also find a weaker relationship for high-carbon intense industries than for low-carbon emitting industries, suggesting that companies in carbon-intensive sectors may face higher transition costs and stricter regulations, which can reduce the immediate financial gains from green initiatives. Finally, our results also document a negative effect of green management on Tobin's Q, implying that market valuations do not fully capture the long-term advantages of sustainable business practices.

The rest of the paper is organized as follows. The next section presents a comprehensive literature review and theoretical background. Section 3 outlines the data and methodology, followed by Section 4, which discusses the results and findings. Section 5 covers the robustness checks and their outcomes, while Section 6 concludes the paper.

2. Literature Review and Theoretical Background

2.1. Green Management: Definition and Empirical Insights

Companies' growing adoption of responsible and sustainable practices ultimately enhances their corporate sustainability. Corporate sustainability is anchored in the "3P" framework—People, Planet, and Profit—which seeks to harmonize social equity, environmental stewardship, and economic viability (Jain, 2019). This framework emphasizes the importance of integrating these three dimensions to develop sustainable business practices that align with stakeholder interests, mitigate environmental impacts, and ensure companies' long-term value creation. The adoption and implementation of green management practices have emerged as an effective tool and corporate trend to enhance corporate sustainability.

Green management is the process within a company that leverages innovation to achieve sustainability, reduce waste, promote social responsibility, and gain a competitive edge through ongoing learning and improvement (Khare et al., 2023). To drive these changes, organizations should implement environmental goals and strategies that align seamlessly with their core objectives, targets, and overall mission (Noronha et al., 2023). Moreover, green management requires companies to take specific actions to prevent pollution arising from the production process (Taylor 1992). Many companies have implemented long-term environmental practices, strategies, and targets that adhere to regulations and address climate change. Their goals include reducing energy consumption, transitioning to renewable sources of energy, offering green products or technologies to consumers, and ultimately decreasing their carbon footprint. Thus, green management encompasses both technical and organizational activities that companies undertake to reduce their environmental impacts and lessen their effects on the environment (Cramer, 1998).

In other words, it signifies the integration of enterprise behavior with environmental awareness (Wu and Wu, 2014).

Corporate green management considerations are gaining increasing attention as stakeholders prioritize sustainability and environmentally responsible practices. This growing attention highlights the importance of understanding how green management practices influence companies' financial performance. As companies increasingly face the challenge of balancing profitability with environmental responsibility, the relationship between green management practices and financial performance has become more critical. Implementing such initiatives often requires substantial strategic shifts and significant investments, making it essential to evaluate their financial implications. These considerations, along with growing interest in sustainability, have given rise to a developing body of literature on the financial impact of green management. Although some studies have investigated the link between environmental management and financial outcomes, the existing literature remains relatively limited and presents mixed findings (Yu and Huo, 2019). Nevertheless, evidence of a positive impact is more prevalent, implying that green management can enhance corporate financial performance (Molina-Azorin et al., 2009). A study by De Haas et al. (2023) indicates that weaker green management practices generally hinder green investments more significantly than credit constraints. Their research suggests that relatively low-cost actions, such as formulating and tracking environmental strategies, setting specific environmental targets, and appointing a manager to oversee climate-related and environmental issues, can enhance a firm's green investments and reduce greenhouse gas and pollutant emissions. Ibishova et al. (2024) suggest that enhancing environmentally friendly initiatives, such as carbon emission reduction efforts, can boost a company's financial performance while supporting environmental responsibility. Moreover, according to Castro et al., 2016), companies with robust

sustainability practices often achieve stronger financial performance, benefiting from enhanced risk management and increased stakeholder engagement.

Alongside positive findings, some studies have indicated a negative or no significant relationship between environmental management and financial performance (Molina-Azorin et al., 2009; Septiavin et al., 2023). For instance, Lankoski (2008) and Lioui and Sharma (2012) indicate that corporate practices focused on social and environmental responsibility can negatively affect financial performance. Earnhart and Lizal (2007) concluded that improved pollution control neither enhances nor diminishes corporate financial performance. Handoko (2012) found that green business practices have a negative but statistically insignificant effect on financial performance, indicating no meaningful impact on financial outcomes.

This discrepancy underscores the complicated nature of the relationship between green management practices and financial performance, and the importance of further exploration to grasp the diverse outcomes observed across different contexts and sectors. Alongside the varied findings, the existing literature presents several limitations that future research should address. Firstly, many studies have employed small sample sizes and short time frames. Given the potential time lag between the implementation of environmental practices and their impact on financial performance, it is essential to conduct longitudinal analyses for more robust insights (Chen et al., 2018; Molina-Azorin et al., 2009). The second limitation is the narrow scope, as several studies primarily focus on specific industrial sectors, such as manufacturing, and certain geographical regions, such as China and the US (Fernandez, 2022; Miroshnychenko et al., 2017; Yu and Huo, 2019). More diverse samples allow the findings to be applicable across different contexts, industries, and regions. So, addressing these limitations can improve the validity and generalizability of findings. Another shortcoming is the limited consideration of variables that

provide deeper insight into firm-level characteristics and broader contextual factors. Existing studies often incorporate fewer control variables related to company-specific attributes, which are crucial for understanding the mechanisms through which green management influences financial outcomes (Li et al., 2017; Molina-Azorin et al., 2009). Additionally, contextual factors, such as national culture, environmental regulations, and economic development, play a significant role in shaping the adoption and impact of green management practices (Chen et al., 2018). Addressing both firm-level and contextual dimensions can enhance our understanding of how green strategies operate across different regions and economic environments.

To address the limitations in the existing literature and bridge important gaps, we aim to answer the research question of **how green management practices impact companies' financial performance across different industries, regulatory settings, and economic contexts**.

2.2 Theoretical Framework and Hypotheses Development

Several theories offer insights into this relationship from various perspectives. The stakeholder theory provides a strong basis for designing green management models, positioning as a socially responsible approach that delivers financial benefits while aligning with stakeholder interests (Brammer and Millington, 2008; McGuire et al., 1988; Nassar and Strielkowski, 2022). This theory suggests that true sustainability management involves substantial contributions to economic, social, and environmental sustainability. In response to stakeholder demands, many companies are now linking green CEO compensation to non-financial indicators, emphasizing leaders' accountability for sustainable practices (Nassar and Strielkowski, 2022). Furthermore, the stakeholder theory underscores environmental accountability and highlights green management as

a tool for effective pollution control and prevention, ultimately enhancing financial performance (Carter and Jennings, 2002; Chen, 2005; Green et al., 2012).

The environmental management theory emphasizes the need for companies to embed environmental considerations within their strategic decision-making processes while proactively applying environmental management practices (Wang et al., 2024). This integrated approach helps create a management model that drives both economic gains and environmental benefits. By cultivating green values within the corporate culture, companies can instill an environmentally responsible mindset and devise strategies that support effective green management initiatives (Zhou et al. 2021).

Several empirical studies reinforce these theoretical insights. For example, current findings show that green management enhances financial performance by improving operational efficiency, attracting environmentally conscious stakeholders, and fostering long-term value creation, all of which can lead to better financial outcomes (De Haas et al., 2023; Lui et al., 2021; Molina-Azorin et al., 2009; Shao and Ünal, 2019). According to Cerciello et al., (2022), green management can enhance company profitability by attracting environmentally responsible investors and fostering stronger stakeholder engagement around sustainability initiatives. As companies commit to sustainable strategies, they typically see improvements in key financial metrics, such as return on assets (ROA), which indicates more efficient asset utilization (Wong et al., 2012). Jell-Ojobor and Raha's (2022) argue that by fostering stakeholder engagement, promoting long-term sustainability, and ensuring efficient use of shareholder equity, sustainable practices can contribute to higher financial outcomes, measured by return on assets and equity. Similarly, Lui et al. (2021) show that implementing green management practices, including energy-efficient technologies and sustainable materials, can enhance a company's ROA. However, some scholars highlight the

challenges and potential negative consequences of green management, suggesting that sustainable practices can hamper financial performance by inducing higher costs, reduced creditworthiness, or having no significant impact on a company's financial outcomes (Fernandez, 2022; Lioui and Sharma, 2012b; Septiavin et al., 2023; Seth et al., 2018).

Given the contradictions in prior findings and limitations in existing literature, such as small sample sizes and short observation periods, this study aims to examine the impact of green management practices on corporate financial performance using a large, longitudinal dataset. Building on theoretical insights and prevalent findings, we propose our **first hypothesis**: green management practices have a positive effect on financial performance, with stronger green management practices associated with higher ROA.

Beyond companies' internal incentives, external factors, particularly the regulatory environment, play a crucial role in driving the adoption of sustainability practices within the company. To combat climate change, some international organizations and countries set climate targets and introduce regulatory frameworks or tools to meet these targets. Emissions trading schemes and carbon taxation are the most important and practical regulatory tools for regulating carbon emissions today. Many countries have implemented these instruments to regulate the level of carbon emissions and address climate change. (Emous et al., 2021). Considering the importance of the regulatory environment in promoting sustainability practices, some theories and hypotheses offer insights from different perspectives. The neo-classical economic theory emphasizes the societal perspective, arguing that companies contributing to pollution often do not bear the full social cost of their environmental impact (Atkinson and Hackler, 2010). This leads to market failure, as the negative externalities are not priced into the companies' operations (Yin, 2012). Consequently, their financial performance may be overstated, and production levels may exceed

what is socially optimal. To address this issue, policymakers can introduce mechanisms such as regulations, environmental taxes, and other requirements, aiming to internalize these external costs. Pigou (1932) argues that pollution creates a gap between the private cost of a product and its total societal cost, highlighting the negative externalities associated with pollution. He proposed that imposing a tax on pollution, reflective of its societal harm, could close this gap and lead to a more efficient market outcome (Metcalf, 2019). In this way, companies' financial performance more accurately reflects their overall societal value. In this context, economic theory supports the implementation of policies that raise the costs for polluting firms. Conversely, for companies that generate positive externalities, such as those engaged in pollution reduction efforts, policies like subsidies can be introduced to internalize the social benefits of their activities, ensuring that their financial performance aligns with the broader societal good (Helbling, 2024).

The Resource-Based View (RBV) claims that when companies adopt an environmental focus, they can strengthen their green management capabilities. This theoretical framework posits that supplier green management, a specialized external capability, promotes sustainable competitive advantages (Chan et al., 2012; Yu and Huo, 2019). RBV argues that companies with an environmental orientation are more likely to implement eco-friendly strategies that drive performance improvement (Grant, 1991). Porter and van der Linde (1995) argue that more efficient use of natural resources can generate a competitive advantage. The Porter Hypothesis suggests that the costs of environmental compliance can be counterbalanced by technological innovations driven by well-designed environmental regulations. In particular, market-based regulations, like Emissions trading schemes (ETS), can foster innovation and improve overall company performance (Yu et al., 2022). Moreover, the weak Porter Hypothesis suggests that well-designed ETS regulations positively impact environmental performance, helping companies achieve carbon

emission reductions. The strong Porter hypothesis further strengthens this by arguing that the benefits from innovation driven by these regulations can outweigh the additional regulatory costs, leading to improved financial performance. In this way, a win-win situation emerges where both the environment and companies benefit (Rubashkina et al., 2015). Some studies indicate that the implementation of ETS and carbon tax can positively impact company value, boosting company revenue and investment intensity (Chan et al., 2013; Marin et al., 2018; Petrick and Wagner, 2014). Aligning with the Porter Hypothesis, Fernandez (2022) shows that green management can promote both product and process innovation, making innovative companies more likely to establish energy and emissions targets and engage in various green investments.

In light of theoretical insights into the regulatory environment and to address the limited investigation of green management and financial performance within such settings, our **second hypothesis** posits that the presence of regulatory frameworks drives the adoption of green management practices, which in turn causally enhance financial performance.

Alongside regulatory settings, the adoption and effectiveness of green management practices are also shaped by other contextual factors, including cultural norms and a country's level of economic development. These aspects are explored through the lens of Institutional Theory and Legitimacy Theory. Legitimacy theory sheds light on the relationship between corporate sustainability practices and financial performance. According to this theory, companies seek to align their actions with the norms, values, and expectations of the societies in order to gain and maintain societal approval (Angelia and Suryaningsih, 2015)**.** In the context of environmental responsibility, this means companies must demonstrate their commitment to sustainability to avoid a "legitimacy gap" and secure the societal validation of their corporate behavior (Andrian, 2020)**.** By embedding green management into their strategic operations, companies signal their

responsiveness to environmental and social concerns. In other words, if a company's values and norms align with societal values, it is more likely to gain legitimacy and attract the support of key stakeholders (Ashforth and Gibbs, 1990; O'Donovan, 2002). Legitimacy, in turn, facilitates broader societal acceptance, enhancing the company's reputation, attracting responsible investors, and reducing regulatory risks. Therefore, integrating environmental objectives through green management practices enables companies to meet both societal and financial goals, supporting the core principles of legitimacy theory (Indriastuti and Chariri, 2021).

Institutional theory posits that external pressures from institutions drive companies to integrate environmental and social factors into their strategies, products, and services, thereby boosting sustainability outcomes (Yu and Huo, 2019). Such pressures from social norms, rules, and structures can also encourage pro-environmental behaviors among employees, reinforcing the link between green management practices and sustainable performance (Li et al., 2021). This theory further suggests that businesses must navigate the constraints set by different institutions, which can enhance their stability, legitimacy, and chances of long-term success (DiMaggio and Powell, 1983; Yu and Huo, 2019). For instance, in their empirical study, Shao and Ünal (2019) find that companies adopting sustainable practices often attract environmentally conscious consumers, potentially strengthening their revenue streams. Furthermore, green management can also boost employee satisfaction and productivity. Davidescu et al. (2020) found that employees in environmentally sustainable companies often show higher motivation and job satisfaction, which can lead to better operational performance and financial results. Companies can enhance their reputation and improve financial performance by aligning their sustainable strategies with the interests of specific stakeholder groups, such as customers within their supply chains (Jell-Ojobor and Raha, 2022). However, institutional and legitimacy pressures, along with empirical

findings, can differ across countries, impacted by their level of economic development. Generally, countries with a high level of development tend to combine stronger environmental awareness with supportive regulatory frameworks and favorable market dynamics, enabling companies to benefit more from sustainability practices. In contrast, companies in less developed countries may face challenges such as limited awareness, weaker incentives, and resource constraints, which undermine the success of green management strategies. Considering the limited contextual analysis that incorporates country development levels, along with insights from the theoretical frameworks, our **third hypothesis** claims that the positive impact of green management practices on company financial performance is stronger in countries with high levels of economic development than in low- or middle-income countries**.**

By incorporating companies from a diverse range of industries, our dataset addresses the narrow scope of prior literature and allows us to explore the dynamics between green management and company financial performance across different industrial sectors. In addition to the abovementioned contextual factors, the carbon intensity level of a company's industry may also moderate the financial implications of green management practices. This moderating effect could stem from varying levels of regulatory burden, implementation costs, and consumer visibility across industries. For example, in low-carbon-intensive sectors, where green practices can be adopted more seamlessly and at lower cost, the financial benefits are more immediate and pronounced. Conversely, high-carbon-intensive sectors often encounter greater compliance costs and structural barriers, which may dampen the short-term financial returns of green management and, in some cases, negatively affect company performance. The literature also points to several challenges in implementing green management, including substantial upfront investments, complex regulatory demands, and the need for continuous innovation, which can hamper financial

outcomes. In contrast to the perspectives of Stakeholder, Institutional, and Neoclassical theories, Traditionalist view posits that improvements in environmental performance can adversely impact corporate financial performance (Lankoski, 2008; Lucato et al., 2017; Septiavin et al., 2023). This perspective argues that investments aimed at enhancing environmental practices often result in increased costs, which can detract from a company's profitability. Aligning with this viewpoint, the "trade-off hypothesis" asserts that there is an inherent negative relationship between environmentally friendly practices and financial performance due to the rising costs associated with such initiatives (Trumpp et al., 2015). This hypothesis highlights the traditionalist view's concerns regarding the financial implications of environmental investments, suggesting that efforts to enhance sustainability might incur costs that hamper the economic success of companies (Trumpp, and Guenther, 2015). Consistent with Traditionalist view, some empirical studies also underscore the potential negative financial impacts of green management practices. For example, Seth et al. (2018) show that small and medium-sized enterprises (SMEs) might face greater financial constraints than larger corporations when adopting sustainable practices. Similarly, Trumpp et al.'s (2015) findings suggest that sustainable practices impose higher costs than the benefits they yield. Fernandez (2022) suggests that adopting green practices can reduce creditworthiness, as lenders may perceive environmentally proactive firms as higher risk. However, some studies suggest that although green management may require considerable initial investment, the long-term advantages often surpass these costs (Mingyi et al., 2024). Chen (2024) argues that companies with strong green management practices are often seen as innovative and forward-looking, which enhances their appeal to equity investors.

Building on these insights and to bridge the gap, our **fourth hypothesis** claims that companies in low-carbon-intensive sectors derive greater financial benefits from green management practices compared to their counterparts in high-carbon-intensive sectors.

3. Data and Methodology

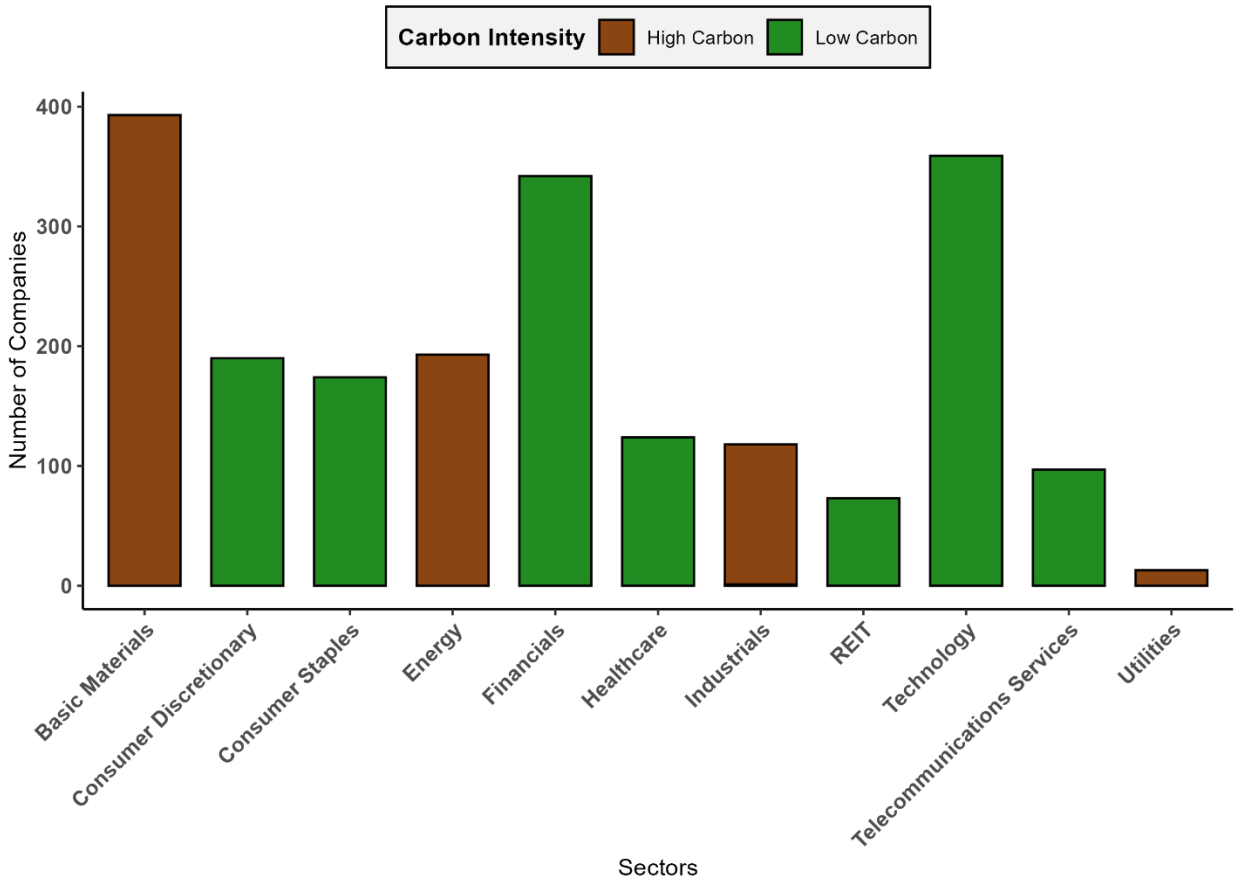
3.1 Data Sample

The dataset consists of annual observations from 2009 to 2018, comprising 12,503 firm-year observations that capture heterogeneity across various dimensions, including company size, industry classification, and country characteristics. Data were sourced from three different databases: green management data from the Carbon Disclosure Project (CDP), financial performance and firm-specific characteristics from Thomson Reuters's DataStream, and country-level data from the World Bank. CDP was established in 2000 to promote greater transparency among firms regarding their climate-change-related risks and opportunities (Blanco et al., 2020). While the CDP data are not without limitations, it is increasingly regarded as reliable and valuable for scholarly research. (Kolk et al., 2008). We coded the CDP questionnaire responses to construct a green management variable and imported additional financial performance indicators and firm characteristics from Thomson Reuters's DataStream.

The dataset includes 1,775 companies from 48 countries across 11 economic sectors, encompassing 24 industrial groups. High carbon intensity sectors include traditional industries such basic materials, energy, industrials and utilities, while low carbon intensity sectors encompass financials, technology, telecommunications and healthcare, among others (***Appendix A***). This broad and diverse sample represents both established industry leaders and emerging firms, capturing a range of company ages and market maturity. illustrates company distribution across

economic sectors. Basic materials, financials and technology are the largest groups, containing approx. 300-400 companies, while REIT and utilities contain less than 100 companies.

Figure 1. Distribution of Companies Across Sectors

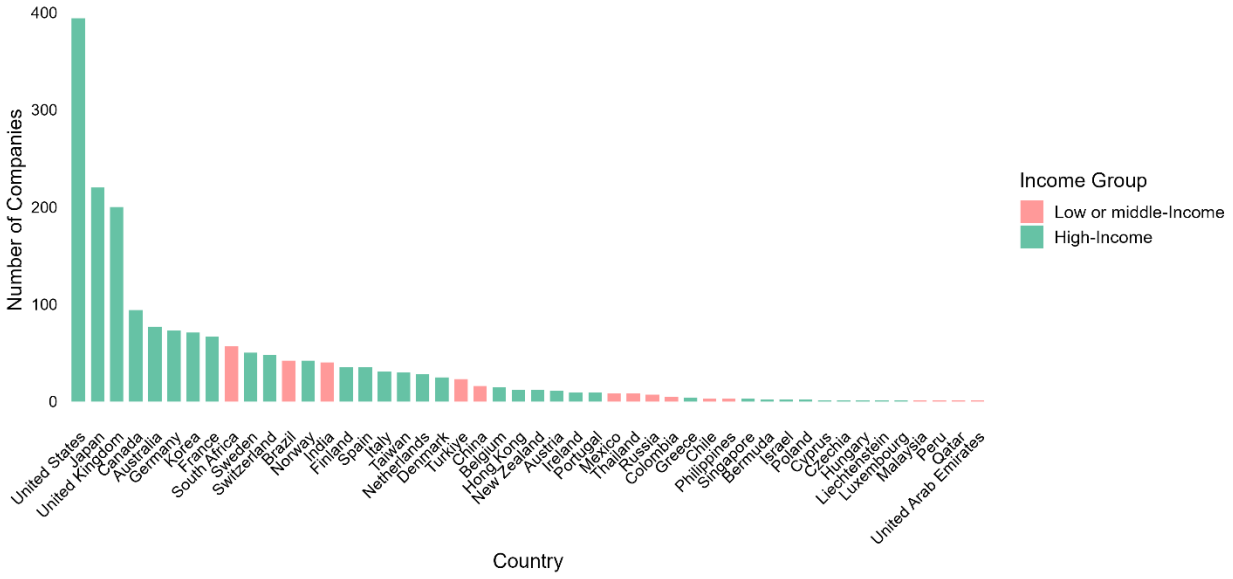


Source: CDP and World Bank data

Spanning seven regions (Europe, the US and Canada, Central and South America, the Middle East, South Africa, Asia, and Australia and New Zealand) and 48 countries, the dataset includes high-income economies such as the United States, United Kingdom, and Germany, alongside low- or middle-income countries like China, India, and Peru, offering insights into diverse economic and regulatory contexts. **Figure *2*** illustrates the spread of companies across various countries,

categorizing them into high-income and low- or middle-income development groups. The three largest countries, the United States, Japan, and the United Kingdom, comprise 45% of the total number of companies. Companies from high-income countries represent 88% and low-income countries 12% of the sample, respectively. The form and timeline of carbon regulations across countries are detailed in **Appendix B**.

Figure 2. Company Distribution Across Countries and Income Levels



Source: CDP and World Bank data

Our dataset addresses key limitations in the existing literature, such as short sample periods, narrow scope, and the lack of longitudinal, regional, and contextual analyses. Incorporating a diverse sample across industries, countries, and income levels over multiple years enables a more comprehensive examination of green management and financial performance.

3.1.1 Variables

We employed Return on Assets (ROA) as the primary financial performance indicator and incorporated additional measures such as Return on Equity (ROE) and Tobin's Q to enhance robustness and validity. In the main analysis, the dependent variable is ROA, a profitability ratio that measures a company's ability to generate profit from its assets (Supriyadi, 2021). It is calculated as the adjusted net income (adding back interest expenses, capitalized interest, and tax rate) divided by the average of the current and previous year's total assets, multiplied by 100 to express the result as a percentage (DataStream). Similarly, ROE is calculated as the net income divided by the average of the current and previous year's book value of equity multiplied by 100.

The main independent variable of interest is the green management variable, constructed based on thirteen questions from the CDP questionnaires (**Appendix C**). These questions cover five green management dimensions - Governance, Business strategy and targets, Emissions Methodology and Verification, Carbon Pricing, and Sustainable Supply Chain. These dimensions demonstrate the internal effort of companies to adapt to climate change while taking anticipatory actions to mitigate or prevent climate-related risks. Based on these dimensions, a total of 13 questions are used to construct the Green Management Z-score (GMZ). In this study, we adopted a modified version of De Haas et al. (2020) and Fernandez (2022)'s approach to constructing z-scores for green management indicators. First, the green management score was computed as the row-wise average of 13 binary (yes/no) indicators, including variables related to managerial responsibility, strategic objectives, emission reduction initiatives, verification methods, carbon pricing mechanisms, and supply chain:

$$GM_i = \frac{1}{13}\sum_{i=1}^{13} x_{ij}$$

where $x_{ij} \in \{1, 0\}$ represents whether firm i meets the j-th green management criterion.

For each firm, the green management score was then standardized within its sector by subtracting the sector-specific mean and dividing by the sector-specific standard deviation, yielding a z-score for the green management (GMZ_i).

$$GMZ_i = \frac{GM_i - \mu_s}{\sigma_s}$$

where μ_s is the green management scores mean for all firms in sector s, and σ_s is the green management scores standard deviation in sector s. A positive GMZ_i indicates that a firm's green management practices exceed the sectoral average, while a negative GMZ_i reflects practices below the sectoral benchmark. This approach ensures comparability across industries by accounting for sectoral differences in green management practices.

To account for the potential influence of unobserved factors, we incorporate 5 firm-level and two country-level variables. Firm-level variables are company size (*SIZE), financial leverage (LEVERAGE), sustainability responsibility (ESG), carbon emission intensity (CO2INT), and carbon (climate) reporting (CREPORT)*. Country-level variables are carbon regulation (*CO2REGL)* and *country income level (GDP)*. *SIZE* and *LEVERAGE* are often employed in financial and economic studies because of their potential impact on company behavior and financial outcomes (Busch et al., 2020; Lewandowski, 2017; Trinks et al., 2020). *SIZE* is defined as the logarithm form of the company's total market capitalization (market value of equity), while *LEVERAGE* is measured by dividing long-term debt by total assets. *ESG* measures a company's level of sustainability responsibility, with a higher ESG score indicating stronger environmental, social, and governance practices. *CO2INT*, which represents the company's carbon emission intensity, is determined by dividing the total CO2 and equivalent CO2 emissions by net sales or revenue. We use the carbon emission intensity ratio as a carbon emission indicator rather than absolute carbon emission levels. Emissions intensity reflects real improvements irrespective of

company growth or contraction, making it a better metric than those that are sensitive to corporate changes and often result in fluctuations in total emissions (Byrd and Cooperman, 2018). *CREPORT,* reflects whether the company provides disclosure on its actions related to climate change and greenhouse gas (GHG) emissions. *CO2REGL* is the country-level variable, which shows if a home country has implemented carbon regulations, such as carbon taxation and cap-and-trade schemes. The second country-level variable is the logarithm of Gross Domestic Product (GDP). GDP represents the total gross value added by producers within a country, along with product taxes minus subsidies that are not already included (Emous et al., 2021).

To handle missing data, observations with incomplete information were removed from the dataset. As a result, the final sample includes an unbalanced panel of 1,822 companies over the period from 2009 to 2018, producing a total of 12,503 firm-year observations. The variables ROA, LEVERAGE, and CO2INT are winsorized at the 5th and 95th percentiles to mitigate the outlier effect.

Table 1. Descriptive Statistics

Variable	Observations	Mean	Median	STD	Min	Max
Return on assets	12503	5.44	4.93	4.75	-4.50	14.36
Green management	12503	0.00	0.19	0.99	-4.03	2.27
Size	12503	16.93	16.61	2.48	4.23	26.57
Leverage	12503	25.19	24.26	15.76	0.00	57.83
Carbon intensity	12503	51.69	31.78	49.15	0.00	122.96
ESG	12503	53.52	59.78	25.03	0.00	95.73
Carbon reporting	12503	0.83	1.00	0.38	0.00	1.00
GDP	12503	28.61	28.62	1.36	22.23	30.66
CO2 regulation	12503	0.51	1.00	0.49	0.00	1.00

Note: *Return on assets*, *Leverage*, *Carbon intensity* winsorized at the 5th and 95th percentiles.STD represents standard deviation.

The descriptive statistics and correlation coefficients of the variables are presented in the following tables. **Table 1** provides an overview of the dataset through descriptive statistics, while **Table 2** indicates no evidence of strong multicollinearity among the variables. Additionally, most correlation coefficients are statistically significant, supporting the robustness of the dataset for further analysis.

Table 2. Correlation Matrix

	I	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*	*IX*
Return on assets	1***								
Green management	0.031***	1***							
Size	0.048***	0.268***	1***						
Leverage	0.113***	0.099***	-0.059***	1***					
Carbon intensity	-0.016**	0.113***	0.050***	0.193***	1***				
ESG	0.033***	0.384***	0.323***	0.045***	0.275***	1***			
Carbon reporting	0.011	0.176***	0.041***	0.033***	0.062***	0.131***	1***		
GDP	0.047***	0.025***	0.081***	0.052***	0.016*	0.160***	-0.004	1***	
CO2 regulation	0.079***	0.164***	-0.110***	-0.065***	-0.13***	-0.045***	0.052***	0.362***	1***

Note. The statistical significance of the correlation coefficients is denoted by asterisks: * p<0.10, ** p <0.05, and *** p<0.01.

3.2 Methodology

3.2.1 Baseline regression

As a baseline regression, we employed a fixed effects (FE) estimation. To confirm the appropriateness of this approach, we conducted diagnostic tests, including the Breusch-Pagan test (Breusch and Pagan 1979), Hausman test (Hausman 1978), and F-test (Wooldridge 2010), to compare analysis results with pooled OLS, fixed, and random effects specifications. The test results indicated that the fixed effects model is the most suitable. However, given concerns about endogeneity, we further applied an instrumental variable (IV) design.

Considering the heterogeneous nature of the dataset, the baseline model incorporates fixed effects at the levels of industry sector, country, firm, and year. Sector-fixed effects account for unobserved factors specific to individual industries, while country-fixed effects capture heterogeneity across countries by addressing unobserved national-level differences. Similarly, firm-fixed effects mitigate the influence of unobserved characteristics unique to individual firms, and year-fixed effects control time-specific shocks or trends. So, the baseline model also incorporates control variables, including *SIZE, LEVERAGE, ESG, CO2INT, CREPORT,* and *GDP*. The baseline model is represented as:

$$\begin{aligned} \boldsymbol{ROA_{i,t}} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1}\, \boldsymbol{GMZ_{i,t}} + \boldsymbol{\beta_2}\, \boldsymbol{SIZE_{i,t}} + \boldsymbol{\beta_3}\, \boldsymbol{LEVERAGE}_{\,i,t} + \boldsymbol{\beta_4}\, \boldsymbol{ESG_{i,t}} \\ + \quad \boldsymbol{\beta_5}\, \boldsymbol{CO2INT_{i,t}} + \boldsymbol{\beta_6} \boldsymbol{CREPORT}_{\,i,t} + \boldsymbol{\beta_7}\, \boldsymbol{GDP}_{\,(c,t)} + \boldsymbol{\alpha_i} + \boldsymbol{\gamma_t} + \boldsymbol{\lambda_s} + \boldsymbol{\delta_c} \\ + \boldsymbol{\varepsilon_{i,t}} \end{aligned}$$

where, $\boldsymbol{ROA_{i,t}}$ represents the financial performance of company, which reflects the return on assets, $\boldsymbol{GMZ_{i,t}}$ represents the standardized green management score, $\boldsymbol{SIZE_{i,t}}$ indicates the size, $\boldsymbol{LEVERAGE}_{\,i,t}$ represents the financial leverage, $\boldsymbol{ESG_{i,t}}$ is a numerical variable that reflects the level of corporate responsibility, $\boldsymbol{CO2INT_{i,t}}$ represents the carbon emission intensity,

$\boldsymbol{CREPORT_{i,t}}$ is a binary variable that indicates whether company has published information regarding its response to climate change and GHG emissions performance, and $\boldsymbol{GDP}_{(c,t)}$ represents the economic size of the home country. Furthermore, $\boldsymbol{\alpha_i}$ denotes firm fixed effect, $\boldsymbol{\gamma_t}$ denotes year fixed effect, $\boldsymbol{\lambda_s}$ denotes sector fixed effect, $\boldsymbol{\delta_c}$ denotes country fixed effect, and $\boldsymbol{\varepsilon_{i,t}}$ is a random disturbance term. Also, *i, s, c,* and *t* represent companies, industry sectors, countries and time dimension, respectively.

3.2.2 Instrument Variable Design (IV)

While Fixed effects estimation accounts for all time-invariant firm characteristics and period-specific effects, mitigating omitted variable bias, it does not fully establish causality (Angrist and Pischke 2009) or eliminate endogeneity concerns. When endogeneity is present, OLS estimates may be biased and inconsistent, necessitating a more robust approach. Endogeneity occurs when an independent variable is correlated with the error term, violating the critical OLS assumption of exogeneity (Wooldridge, 2005). Specifically, endogeneity can arise in three situations that violate the exogeneity condition, which are errors-in-variables, omitted variables, and reverse causality (Bascle, 2008). The errors-in-variables issue arises when the true value of a variable is not directly observed but measured with error. In our case, this could occur if reported green management data are imprecise, misreported, or subject to self-reporting bias. Such measurement errors can weaken the estimated relationship between green management and financial performance, leading to biased and inconsistent OLS estimates. Additionally, reverse causality is a concern in our model, as financially stronger companies may be more likely to adopt improved green management practices to enhance both environmental and financial outcomes. When reverse causality is present, the explanatory variable and error term are correlated, causing OLS estimation to capture both forward and reverse effects, leading to biased and inconsistent coefficients. Omitted variable

bias is also relevant in our context, as both green management and financial performance are likely correlated with various economic factors. Failing to control for these variables properly may result in a biased and overstated direct relationship, causing OLS estimates to overstate the actual effect (Zheka 2007).

One of the solutions to address the endogeneity problem is the use of instrumental variable (IV) estimation. IV estimation involves introducing an instrument into the analysis to transform an endogenous regressor into an exogenous one, addressing the above-mentioned endogeneity concerns. So, we extend the fixed effects analysis using an IV approach. The careful application of IV design has some requirements. First, to accurately estimate the causal effect, the instrument must be both relevant and satisfy the exclusion restriction (Sieweke et al., 2023). Relevance implies that the instrument must have a strong influence on the endogenous explanatory variable, as weak instruments may produce biased estimates and fail to provide the statistical power needed to identify an effect (Semadeni et al., 2014). The exclusion restriction dictates that the instrument should only affect the dependent variable through its impact on the endogenous explanatory variable, without any direct effect on the outcome itself (Semadeni et al., 2014). In our empirical context, a valid exogenous instrument means it does not influence the company's financial performance. Furthermore, the instrument should impact the company's financial performance only through its effect on green management variables, without directly affecting performance itself.

To identify the presence of endogeneity in our model, we conducted the Durbin-Wu-Hausman test (Durbin, 1954; Hausman, 1978; Wu, 1973), which revealed endogeneity problems. To resolve this issue, we use the exogenous variable *CO2REGL* as an instrument. This variable indicates whether a country has implemented carbon emission regulations, such as a carbon tax or

emission trading schemes (ETS). The presence of such regulations significantly drives companies to reduce emissions. Typical regulatory responses by companies, such as participation in ETS systems and adoption of internal carbon pricing tools, are captured by our green management variable. This establishes *CO2REGL* as a relevant instrumental variable. Additionally, these kinds of green management engagements impose costs on firms. Therefore, such carbon regulations influence financial performance through green management practices, ensuring compliance with the exclusion restriction. So, *CO2REGL* satisfies both the relevance and exclusion restriction conditions required for a valid exogenous instrument. Secondly, IV estimation also requires assessing the validity and strength of the instruments to ensure reliable results. Although the large sample size helps mitigate finite-sample bias (Hahn and Hausman 2002), instruments can remain weak, even in very large samples, such as ours. Also, it is critical to note that the 2SLS estimator is only reliable if the instruments are strong enough. Weak instruments will result in a biased 2SLS estimator and unreliable hypothesis tests derived from 2SLS (Zheka 2007). The literature suggests various estimators and tests to assess the strength and validity of instruments. In order to verify the validity of our instrument, we conducted relevant diagnostic tests. The weak instrument test yielded an F-statistic of 17.88 ($p = 2.37x10^{-5}$ or <0.001, which exceeds the Stock-Yogo critical value of 16.38 for a 10% maximal IV size bias. This allows us to reject the null hypothesis, indicating that our instrument is not weak (Stock and Yogo 2003). Additionally, the Wu-Hausman (Hausman 1978; Wu 1973) endogeneity test produced a statistic of 13.35 ($p =<0.001$), rejecting the null hypothesis of exogeneity and confirming that an instrumental variable approach is necessary. As a result, CO2REGL serves as a strong and valid instrument for addressing endogeneity concerns. We implement a two-stage least squares (2SLS) estimation, where in the

first stage, endogenous treatment variable CO2 regulation (CO2REGL) is regressed on green management (GMZ) along with other covariates, year, sector, country fixed effects:

$$\boldsymbol{GMZ_{i,t} = \beta_0 + \beta_1\ CO2REGL_{i,t}\ + X_{i,t}\Gamma' + \gamma_t + \lambda_s +\ \delta_c + \varepsilon_{i,t}} \quad (2)$$

where $X_{i,t}$ is the vector of control variables, $\boldsymbol{GMZ_{i,t}}$ is the standardized green management score, $\boldsymbol{CO2REGL_{i,t}}$ is the instrument variable indicating if a home country has implemented carbon regulations, such as carbon taxation and cap-and-trade schemes.

In the second stage, we regress the outcome variable (ROA) on the predicted values of GMZ, as well as control variables and fixed effects.

$$\boldsymbol{ROA_{i,t} = \beta_0 + \beta_1\widehat{GMZ}_{i,t}\ + X_{i,t}\Gamma' + \gamma_t + \lambda_s +\ \delta_c + \varepsilon_{i,t}} \quad (3)$$

where $\boldsymbol{\widehat{GMZ}_{i,t}}$ is the predicted $\boldsymbol{GMZ_{i,t}}$ obtained from regressing $GMZ_{i,t}$ on $\boldsymbol{CO2REGL_{i,t}}$, $\boldsymbol{X_{i,t}}$ and the fixed effect components of the model. The definition of other components is the same as before.

4. Results and Discussions

Table 3 presents the results of the baseline model (FE) and IV estimation analyses. The results of these two models indicate a significant positive impact of green management on the financial performance of companies. The baseline models suggest that companies with stronger green management practices tend to achieve better financial performance. In other words, one standard deviation increase in the green management z-score (GMZ) is associated with a 0.156 percentage point increase in return on assets (ROA), holding other factors constant. This result is consistent with the first hypothesis, reinforcing the notion that the implementation of green management practices positively influences financial performance. Moreover, the impact of green management is even more pronounced when using the IV approach, indicating that addressing potential endogeneity strengthens the observed relationship. The IV results suggest a positive causal effect

of green management practices on a company's financial performance. Specifically, the coefficient of GMZ indicates that one standard deviation increment in the green management z-score (GMZ) is associated with a 4.590 percentage point increase in return on assets (ROA), ceteris paribus. This finding supports our second hypothesis that green management practices causally enhance profitability, where country carbon regulation serves as the instrumental variable.

Beyond the main effect of green management, the analysis reveals how various control variables contribute to explaining corporate financial performance. Across both fixed effects (FE) and instrumental variable (IV) models, **financial leverage** demonstrates a consistently negative and statistically significant relationship with ROA, suggesting that higher debt levels may reduce profitability. **Company size** is positively associated with ROA in the FE model, indicating possible scale advantages or better resource allocation in larger firms; however, the effect is not significant in the IV model, potentially reflecting endogeneity or instrument-related variation. The **ESG score** exhibits a small but negative association with ROA in both models. **Carbon intensity** is negatively associated with ROA in both models; however, the relationship is statistically significant only in the FE model, implying that reducing carbon intensity can enhance firm profitability. **Carbon reporting** demonstrates contrasting results across the two models. While its coefficient is positive but insignificant in the FE model, it turns negative and statistically significant in the IV model, suggesting that the impact of reporting on financial performance may be influenced by endogeneity or the underlying motivations behind disclosure**.** Lastly, the negative relationship between GDP and ROA observed in both models suggests that higher GDP may reduce the financial benefits for companies, implying that firms in wealthier or more regulated countries face higher compliance costs or operational burdens. These findings underline the importance of accounting for both firm-

specific characteristics and broader contextual factors when evaluating the financial outcomes of sustainability strategies.

Table 3. Regression results

Models	Fixed Effect	Instrumental Variable
Variables	ROA	ROA
Green management	0.156*** [0.060]	4.590*** [1.708]
Company size	2.693*** [0.075]	0.240 [0.248]
Financial leverage	-0.09*** [0.004]	-0.054*** [0.009]
ESG	-0.006* [0.003]	-0.054*** [0.011]
Carbon intensity	--0.008*** [0.003]	-0.003 [0.003]
Carbon reporting	0.202 [0.156]	-4.869*** [1.742]
GDP	-1.321*** [0.303]	-0.806*** [0.630]
Country fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Firm fixed effects	Yes	No
Adjusted R-squared	0.6637	0.281
Observations	12503	12503

Note. The statistical significance of the regression parameters is denoted by asterisks: * p<0.10, ** p <0.05, and *** p<0.01. The models use industry, country, year, and firm fixed effects. Standard errors are clustered at firm and year levels and presented in square brackets.

We conducted the Breusch-Pagan test (Breusch and Pagan, 1979) to check for heteroskedasticity in our models, and the results revealed the presence of heteroskedasticity in the residuals. To address both heteroskedasticity and potential serial correlation, we clustered standard errors at both the firm and year levels across all models. This approach accounts for within-firm autocorrelation over time and cross-sectional dependence within years.

To further explore how different contexts might influence the relationship between green management practices and company financial performance, we conduct additional analyses using two distinct subsamples. The first analysis focuses on the income levels of countries, aiming to investigate whether the impact of green management on a company's financial performance varies depending on the income level of its home country. Following the UN classification, we categorize

countries into two groups: high-income and low- or middle-income countries (Mahler et al., 2024; United Nations, 2024). Using this classification, we created a subsample from our original dataset to examine potential differences in this relationship between countries in the two income groups. **Table 4** presents the estimation results. Our results indicate a noticeable distinction in the impact of green management on financial performance depending on the income level of the company's home country. Moreover, the results demonstrate that while companies in high-income countries benefit from implementing green management practices, the financial performance of companies in low- or middle-income countries is not affected by such practices.

Table 4. Results for Country Development Level Analysis

	High-income Countries	Low- or middle-income Countries
Variables	ROA	ROA
Green management	5.216** [2.142]	1.020 [1.931]
Company size	0.160 [0.311]	0.637*** [0.244]
Financial leverage	-0.051*** [0.011]	-0.053*** [0.016]
ESG	-0.060*** [0.015]	-0.027* [0.012]
Carbon intensity	-0.005 [0.004]	0.006** [0.003]
Carbon reporting	-5.501** [2.159]	-0.642 [2.057]
GDP	-1.014 [0.830]	-0.113 [0.964]
Country Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Adjusted R-squared	0.279	0.332
Observations	11093	1410

Note. The statistical significance of the regression parameters is denoted by asterisks: * p<0.10, ** p <0.05, and *** p<0.01. The models use industry, country, year, and firm fixed effects. Standard errors are clustered at firm and year levels and presented in square brackets.

In other words, in high-income countries, a one standard deviation increase in the green management z-score (GMZ) is associated with a 5.216 percentage point increase in return on assets (ROA), holding other factors constant. In contrast, the corresponding effect in low- and middle-

income countries is only 1.020 percentage points and statistically insignificant. The reason for this difference could be attributed to several factors. Generally, high-income level countries have more advanced regulatory frameworks and stronger environmental awareness than low- or middle-income nations (de Freitas Netto et al., 2020). As a result, many high-income countries implement stricter regulations and offer greater incentives for green initiatives, such as subsidies, tax credits, and carbon trading systems. These measures help align corporate economic incentives more closely with societal interests by internalizing both negative and positive externalities. In contrast, low- or middle-income countries may lack these supports, leading companies to face higher costs without regulatory or financial assistance to offset them.

Additionally, in certain low- or middle-income countries, businesses might not fully recognize the long-term value of green practices due to limited environmental awareness and a lack of understanding of how sustainability can impact financial performance. Furthermore, resource constraints, such as limited financial capital, technical expertise, or access to sustainable technologies, can exacerbate these challenges. As a result, companies in low- or middle-income countries often struggle to implement effective green management practices, which may lead to higher costs without immediate financial gains. Lastly, market conditions and cultural factors can also be crucial elements. Unlike high-income countries, low- or middle-income countries may not have market conditions that support the financial benefits of green management. These cultural and market dynamics represent forms of market failure that can hinder the success of green management strategies.

Our second subsample analysis focuses on the carbon intensity levels of industrial sectors, examining whether the relationship between green management and financial performance varies

across sectors with different carbon intensities. To do so, we classify sectors as high or low-carbon intensive based on their average carbon emission intensity.

According to the Global Industry Classification Standard, our dataset includes companies from 11 sectors spanning 24 industry groups (Viana 2024). Sectors with an average carbon emission intensity exceeding 100 tonnes per $1 million in revenue are categorized as high-carbon-intensive, including Utilities, Industrials, Energy, and Materials. [2] In contrast, low-carbon-intensive sectors comprise Consumer Discretionary, Consumer Staples, Health Care, Financials, Information Technology, and Communication Services. We employ IV estimations in this model to control endogeneity and ensure robust results. As shown in **Table 5**, the effect of green management on financial performance is positive and significant in low-carbon-intensive sectors but positive yet insignificant in high-carbon-intensive sectors. In low-carbon-intensive sectors, a one standard deviation increase in the green management z-score (GMZ) is associated with a 4.485 percentage point increase in return on assets (ROA), holding other factors constant. In high-carbon-intensive sectors, the corresponding effect is 3.756 percentage points, but this result is not statistically significant. Our results reveal that companies in low-carbon-intensive sectors benefit more from implementing green management practices compared to their counterparts in high-carbon-intensive sectors. Similar to Bolton and Kacperczyk's (2020) findings, where excluding salient, high-carbon-intensive sectors from the sample strengthens the carbon premium effect, our results show a more pronounced and significant positive relationship between green management and financial performance in low-carbon sectors. This suggests that in high-carbon-intensive sectors, the impact of green management on financial performance may be overshadowed by other factors, similar to how emissions have less influence on returns in those industries (Bolton and Kacperczyk

[2] https://www.visualcapitalist.com/the-most-carbon-intensive-sectors-in-the-world/

2020). One of the key driving factors for this distinction could be regulatory and compliance costs. High-carbon-intensive sectors are often facing environmental regulations, forcing them to make considerable investments in emission reduction and compliance. These investment costs may exceed the financial benefits of green management, and the returns could take longer to materialize. Conversely, low-carbon-intensive sectors are subject to fewer regulatory burdens and can implement green management practices at lower costs, making the financial benefits more apparent in the short-term. Moreover, companies in low-carbon-intensive sectors often have established efficient processes, allowing them to integrate green management practices more seamlessly and realize financial gains more quickly. Another contributing factor could be consumer awareness and competitive advantage. Companies in low-carbon-intensive industries may have greater opportunities to differentiate themselves through sustainability initiatives, attracting eco-conscious consumers and strengthening their brand reputation.

Table 5. Sectoral Analysis Results

	Low-Carbon Intensive Sectors	High-Carbon Intensive Sectors
Variables	ROA	ROA
Green management	4.485** [1.987]	3.756 [2.665]
Company size	0.091 [0.295]	0.728* [0.378]
Financial leverage	-0.049*** [0.013]	-0.06*** [0.013]
ESG	-0.057*** [0.014]	-0.036** [0.017]
Carbon intensity	-0.001 [0.004]	-0.01*** [0.002]
Carbon reporting	-4.454** [2.013]	-4.603* [2.742]
GDP	-1.942*** [0.696]	0.068 [1.237]
Country Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Adjusted R-squared	0.29	0.277
Observations	8031	4472

Note. The statistical significance of the regression parameters is denoted by asterisks: * p<0.10, ** p <0.05, and *** p<0.01. The models use industry, country, year, and firm fixed effects. Standard errors are clustered at firm and year levels and presented in square brackets.

While high-carbon industries may struggle to leverage green management for competitive advantage, as sustainability improvements often occur in the production processes, making them less noticeable to customers. Finally, technological and industry constraints may shape this relationship in distinct ways. High-carbon-intensive sectors, such as Oil and Gas, Construction often face limited technological alternatives for reducing emissions without substantial capital investment, as transitioning to low-carbon technologies is both complex and costly. In contrast, low-carbon-intensive sectors, such as Banks and Insurance, Software and Services can integrate green practices with minimal disruption, leading to faster financial returns. Overall, the lack of a significant financial benefit in high-carbon-intensive sectors does not necessarily imply that green management is ineffective but instead that the costs, risks, and structural challenges are higher compared to low-carbon-intensive sectors.

In contrast, low-carbon-intensive sectors can integrate green practices with minimal disruption, leading to faster financial returns. Overall, the lack of a significant financial benefit in high-carbon-intensive sectors does not necessarily imply that green management is ineffective but instead that the costs, risks, and structural challenges are higher compared to low-carbon-intensive sectors.

In summary, the results of these two analyses provide strong support for our third and fourth hypotheses.

5. Robustness Check

To assess the robustness of our results, we conducted additional analyses using alternative dependent and independent variables within an IV/2SLS framework. As alternative dependent variables, we employed *ROE* and *Tobin's Q* to examine potential variations in our findings. ROE measures a company's profitability relative to shareholders' investment, indicating how effectively a firm generates returns on equity capital (Gallego-Álvarez et al., 2015). The analysis with *ROE*

revealed a positive and statistically significant effect of green management on corporate financial performance, consistent with the results from our ROA estimation. While the dataset for the *ROE* analysis contained slightly fewer observations than the original (12,407 samples), the direction and sign of the GMZ coefficient remained stable, with a larger magnitude, further confirming the robustness of our findings (**Appendix D**).

In addition to ROE, we included Tobin's Q as the dependent variable in our robustness check to capture a market-based perspective on firm value. Tobin's Q represents the ratio of a firm's market value to the replacement cost of its assets (Tobin, 1969). Employing Tobin's Q allows for the assessment of company market value, as this ratio provides insight into the stock market's expectations regarding future profitability and growth (Kor and Mahoney, 2005). It is calculated by dividing the market value of the equity (including total liabilities) by the book value of total assets (Singh et al., 2017). The results indicate that while green management positively affects ROA and ROE, its impact on Tobin's Q is negative and significant. It is often expected that financial variables containing market expectations influence estimations differently as they incorporate forward-looking market information alongside backward-looking accounting data. (Horváthová 2010). This result is consistent with Hatalis's (2024) findings, which indicate that green management practices, such as purchasing carbon offsets or renewable energy certificates (RECs), are associated with higher sales, profitability, and assets but a lower Tobin's Q for REC buyers. Prior research also presents contradictory findings when combining accounting-based and market-based financial measures. Some studies have reported contradictory findings when using accounting-based and market-based financial variables in their analyses. Some studies have reported contradictory findings when using accounting-based and market-based financial variables in their analyses. For instance, Delmas et al. (2015) found that improvements in corporate

environmental performance led to a decrease in return on assets while increasing Tobin's Q. In contrast, Lewandowski's (2017) findings show that carbon emission mitigation is significantly and positively related to return on sales (ROS) but negatively associated with Tobin's Q. Similarly, Emous et al. (2021) indicate that carbon emissions reduction improves return on assets, return on equity, and return on sales, yet has no significant effect on Tobin's Q. Overall, this contrast may arise from the inherent differences between these performance measures. As accounting-based indicators, ROA and ROE reflect immediate financial benefits such as cost reductions and operational improvements. Conversely, Tobin's Q captures investor expectations and broader market conditions, which may be shaped by concerns about the costs, risks, or uncertain payoffs associated with sustainability initiatives. A negative relationship suggests that while green management may enhance internal financial performance, investors could view it as a costly strategy with uncertain long-term benefits, potentially leading to unnecessary expenditures that deplete a firm's resources and reduce its profits (Delmas and Nairn-Birch, 2011). In other words, while improvements in green management can enhance profitability, companies may still face investor penalties for strengthening their green management practices. Thus, even though green management improves operational performance in the short run, its effect on market valuation may depend on investor decisions and external market conditions.

To further strengthen our analysis, we introduced *GM_Score* and *GM_Dummy* as alternative measures of green management practices. *GM_Score* represents the average green management score, calculated as the row-wise mean of 13 binary (yes/no) green management indicators. *GM_Dummy* is a binary variable set to 1 if a company's *GM_Score* exceeds the sector average and 0 otherwise. As shown in the table, the results for these alternative independent variables align with our main model, reinforcing the robustness of our findings (**Appendix E**).

6. Conclusion and Implications

6.1 Conclusion

As companies increasingly prioritize sustainability in response to the intensifying climate crisis, green management has emerged as a strategic approach to achieving competitive advantage and long-term value creation. This study contributes to the growing body of literature by providing robust evidence of the financial benefits of green management practices. Using a comprehensive panel dataset spanning 12,503 firm-year observations across 48 countries and 20 industrial sectors over a 10-year period, our findings demonstrate that green management, measured by the Green Management Z-Score (GMZ), has a positive and significant impact on corporate financial performance. Specifically, firms with higher green management scores experience improved financial outcomes, as reflected in return on assets (ROA), with robustness checks using return on equity (ROE) further supporting this relationship.

To address potential endogeneity concerns and better understand the causal relationship between green management and financial performance, we employed an instrumental variable (IV) approach, using country-level carbon regulation as an instrument for green management. The IV analysis confirms a positive causal effect of green management on financial performance, suggesting that corporate commitment to sustainability not only aligns with environmental goals but also causally enhances profitability. This causal evidence further strengthens the argument that green management is a driver of financial success.

Our sectoral analysis highlights important differences in the financial benefits of green management across industries. Companies in low-carbon-intensive sectors tend to derive greater financial rewards from adopting green management practices than their counterparts in high-carbon-intensive industries. This disparity may stem from the greater operational flexibility and

lower regulatory compliance costs faced by low-carbon sectors, which enable them to leverage sustainability initiatives more effectively. Conversely, high-carbon-intensive sectors face higher transition costs and regulatory pressures, which may limit the financial returns from green management efforts.

The additional analysis also reveals notable differences based on country income levels. In high-income countries, green management practices have a stronger positive impact on financial performance compared to low- or middle-income countries, where the relationship, while still positive, is not statistically significant. This suggests that the financial benefits of green management may be more readily realized in high-income economies, where resources, infrastructure, and regulatory frameworks better support sustainability initiatives.

Interestingly, while green management has a significant positive effect on ROA, its impact on Tobin's Q is negative. This suggests that while green management enhances operational performance, its impact on market valuation may be limited by investor skepticism, market dynamics, and uncertain long-term benefits.

In conclusion, this study highlights green management as a strategic driver of both environmental responsibility and financial success, emphasizing its crucial role in long-term business strategy.

6.2 Policy recommendations

Our findings have significant implications for corporate decision-makers, investors, and policymakers. Overall, the results indicate that adopting green management practices can enhance the financial performance of companies. Additionally, our contextual analysis suggests that firms, particularly in low-carbon-intensive industries and high-income countries, should actively integrate green management into their core strategies to achieve both financial and environmental

benefits. However, companies in high-carbon industries and low- or middle-income countries may require tailored strategies to capture the benefits of green management practices, as well as governmental intervention providing regulatory frameworks and mechanisms that can, to a larger extent, align corporate and social incentives.

Investors and other stakeholders play an important role in shaping corporate sustainability priorities. To increase sustainability awareness and change the perception of green management from a cost to a strategic investment, companies should actively report on how green management and sustainability initiatives drive efficiency, mitigate risks, and create long-term value. So transparent sustainability reports, ESG disclosures, and third-party verifications can attract both environmentally conscious consumers and long-term investors. Additionally, supply chain engagement should be prioritized in order to lessen supply chain emissions, and collaborating with sustainable partners can further strengthen their market position.

Policymakers can further support these efforts by developing targeted incentives and regulatory frameworks, and mechanisms that promote green investments and sustainability initiatives. This includes market-based mechanisms and financial incentives such as tax benefits or subsidies for green innovations, appropriate shadow prices for carbon emissions, as well as regulatory mechanisms such as enhanced transparency requirements to ensure accountability (such as EU's Taxonomy and Corporate Sustainability Reporting Directive, CSRD).

This paper offers valuable insights into the relationship between green management and financial performance, yet some limitations open avenues for further research. Our data covers the period from 2009 to 2018, meaning that the recent policy developments, corporate climate commitments, such as net-zero targets, and advancements in green technologies are not considered. Future research could extend the timeframe to explore this relationship within the

context of evolving regulatory and market dynamics. Furthermore, this study does not examine the moderating effect of firm-specific characteristics on the relationship between green management and financial performance. For instance, corporate governance quality, corporate responsibility, and leadership commitment could all influence the effectiveness of green management initiatives. Future research could investigate these factors to provide a more nuanced understanding of how internal firm factors shape the financial outcomes of green management practices.

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Appendix A. Industrial groups and Economic sectors

N	Industry groups	Economic Sector
1	Oil and Gas	**Energy**
2	Energy utility networks Renewable power generation Thermal power generation	
3	Forest and Paper Products - Forestry, Timber, Pulp and Paper, Rubber	**Basic materials**
4	Construction	
5	Metallic mineral mining	
6	Chemicals	
7	Professional Services	**Industrials**
8	Ground Transportation	
9	Research & Consulting Services	
10	Aerospace and Defense	
11	Automobiles and Components	**Consumer Discretionary**
12	Retailing	
13	Consumer Services	
14	Hotels Restaurants and Leisure and Tourism Services	
15	Consumer Durables Household and Personal Products	**Consumer Staples**
16	Food and Beverage Processing	
17	Telecommunication Services	**Telecommunications Services**
18	Print & publishing services	
19	Technology Hardware and Equipment	**Technology**
20	Software and Services	
21	Banks Diverse Financials and Insurance	**Financials**
22	Non-energy and/or water utilities	**Utilities**
23	Real Estate	**REIT**
24	Health Care Providers and Services and Healthcare Technology	**Healthcare**

Source: (Viana 2024)

Appendix B. Carbon regulation timeline across countries

N	Country	Carbon Tax	ETS
1	Australia	2012-2014	-
2	Austria	2022	2005
3	Belgium	-	2005
4	Bermuda	-	-
5	Brazil	-	-
6	Canada	2019	-
7	Chile	2017	-
8	China	-	2021
9	Colombia	2017	-
10	Cyprus	-	2005
11	Czech Republic	-	2005
12	Denmark	1992	-
13	Finland	1990	-
14	France	2014	2005
15	Germany	-	2005
16	Greece	-	2005
17	Hong Kong	-	-
18	Hungary	-	2005
19	India	-	-
20	Ireland	2010	2005
21	Israel	-	-
22	Italy	-	2005
23	Japan	2012	-
24	Liechtenstein	2013	2008
25	Luxembourg	2021	2005
26	Malaysia	-	-
27	Mexico	2014	
28	Netherlands	-	2005
29	New Zealand		2008
30	Norway	1991	2007
31	Peru	-	-
32	Philippines	-	-
33	Poland	1990	-
34	Portugal	2015	2005
35	Qatar	-	2005
36	Russia	-	-

37	Singapore	2019	-
38	South Africa	2019	-
39	South Korea	-	2015
40	Spain	2014	2005
41	Sweden	1991	-
42	Switzerland	2008	2008
43	Taiwan	-	-
44	Thailand	-	-
45	Turkiye	-	-
46	United Arab Emirates	-	-
47	United Kingdom	2013	2005
48	United States	-	-

Appendix C. Questions from the CDP Questionnaire

- Is there board-level oversight of climate-related issues within your organization?
- Do you provide incentives for the management of climate-related issues, including the attainment of targets?
- How your organization's processes for identifying, assessing, and managing climate-related issues are integrated into your overall risk?
- Are climate-related issues integrated into your business strategy?
- Did you have an emissions target that was active in the reporting year?
- Did you have emissions reduction initiatives that were active within the reporting year?
- Do you classify any of your existing goods and/or services as low-carbon products or do they enable a third party to avoid GHG emissions?
- Do you engage with your value chain on climate-related issues?
- Indicate the verification/assurance status that applies to your reported emissions.
- The name of the standard, protocol, or methodology you have used to collect activity data and calculate Scope 1 and Scope 2 emissions"
- Are any of your operations regulated by a carbon pricing system (e.g., ETS, Cap & Trade, Carbon Tax)?
- Has your organization originated or purchased any project-based carbon credits within the reporting period?
- Does your organization use an internal price on carbon?

Appendix D. Robustness Check Analysis with different FP variables

Variables	ROE	Tobin's Q
Green management	10.046*** (2.222)	-0.205* (0.110)
Company size	0.817 (0.567)	0.104*** (0.016)
Financial leverage	-0.072*** (0.012)	0.0001 (0.0006)
ESG	-0.1001*** (0.025)	-0.0005 (0.0007)
Carbon intensity	-0.028*** (0.005)	-0.0002 (0.0002)
Carbon reporting	-10.42** (3.85)	0.144 (0.114)
GDP	-2.23** (1.316)	-0.079 (0.043)
Country Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Observations	12420	12590

Note. The statistical significance of the regression parameters is denoted by asterisks: * p<0.10, ** p <0.05, and *** p<0.01. The models use industry, country, year, and firm fixed effects. Standard errors are clustered at firm and year levels and presented in square brackets.

Appendix E. Robustness Check with different GM variables

Variables	ROA	ROA
Green management Score	30.34** (12.394)	
Green management Dummy		7.887*** (2.884)
Company size	0.086 (0.335)	0.386* (0.192)
Financial leverage	-0.060*** (0.013)	-0.049*** (0.008)
ESG	-0.061*** (0.015)	-0.047*** (0.009)
Carbon intensity	-0.004 (0.003)	-0.00002 (0.002)
Carbon reporting	-6.163** (2.436)	-2.371*** (0.808)
GDP	-0.622 (0.734)	-0.909 (0.591)
Country Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Observations	12503	12503

Note. The statistical significance of the regression parameters is denoted by asterisks: * p<0.10, ** p <0.05, and *** p<0.01. The models use industry, country, year, and firm fixed effects. Standard errors are clustered at firm and year levels and presented in square brackets.