Do Family Firms Walk the Talk? Global Insights into Carbon-Washing

Abstract

As societal awareness of carbon emissions intensifies, firms increasingly report satisfactory environmental performance to meet regulatory standards and fulfil legitimacy expectations. However, this trend has also given rise to carbon-washing, a subset of greenwashing, characterised by the contradictory phenomena of high carbon emissions despite sound environmental performance. Based on the understanding of carbon-washing, this study focuses on investigating the role of ownership structure in carbon-washing behaviours by comparing family businesses to non-family businesses. Integrating legitimacy and signalling theories with the socioemotional wealth concept, the findings confirm the presence of carbon-washing, also revealing that family businesses are less willing to engage in carbon-washing practices than non-family businesses. This study further investigates the heterogeneity of carbon-washing at firm, industry, and country levels, including ESG reputation, the implementation of the Carbon Emission Trading Scheme, legal contexts, and the influence of national culture. Our findings challenge the conventional assumption that a high environmental performance rating aligns with genuine carbon emissions reduction, highlighting the nuances of corporate carbon-washing behaviours between family and non-family firms.

Keywords: Carbon-washing, family business, reputation, ETS, Jurisdiction, legitimacy theory, signalling theory, SEW

1. Introduction

With growing scientific evidence and societal awareness of the profound impact of carbon emissions on climate change, there has been mounting pressure on companies to prioritise carbon reduction initiatives (Bui et al., 2020; Peng et al., 2023). Many companies have responded to this pressure by actively reporting the incorporation of carbon-reduction strategies in their business models, policies and practices (Bingler et al., 2024; Suchman, 1995; Treepongkaruna et al., 2024). However, initiatives to curb carbon footprint often involve significant capital investment, yet the outcome is uncertain (Dechezleprêtre et al., 2023). This creates a "sandwich effect," where businesses are caught between stakeholder pressure to demonstrate a sound carbon performance and, simultaneously, the financial and operational challenges to achieve the targeted emission reduction. Consequently, some firms may be tempted to adopt behaviour that engages in symbolic carbon-reduction actions and communications ("the talk") to maintain or obtain legitimacy among stakeholder groups, rather than adopting practices that conclusively reduce carbon emissions ("the walk"). This behaviour is referred to as carbon-washing (García-Meca et al., 2025; Peng et al., 2024). Carbon-washing is a subset of greenwashing that specifically involves firms using impression management to obscure poor carbon performance and gain legitimacy (Seele & Gatti, 2017; Siano et al., 2017; Torelli et al., 2020). It often involves exaggerating positive actions to present a misleadingly greener image to stakeholders (Torelli et al., 2020), but often lacks genuine commitment to reduce carbon emissions (Berrone et al., 2017; Bingler et al., 2024; Siano et al., 2017; Walker & Wan, 2012; Zhang, 2023).

The motivation in this study for focusing on carbon-washing rather than greenwashing is twofold. One, the strong demand from stakeholders, regulators, and investors has prompted firms to adopt various strategies and initiatives to address carbon-related issues. A side effect of such a

phenomenon is that management engages in symbolic communication for legitimacy with minimal substantive efforts, i.e., carbon-washing. This is supported by the ESG literature, which documents that firms under societal pressure to address ESG issues may opt for greenwashing rather than genuine investments to enhance their environmental performance (Walker & Wan, 2012; Seele & Gatti, 2017; Torelli et al., 2020; Peng et al., 2024). Two, despite a large body of research on greenwashing across various disciplines within social science, it is challenging to measure the extent of greenwashing due to its broad scope and the difficulty of accurately capturing firms' substantive ESG/CSR efforts versus symbolic communications. On the other hand, the scope of carbon-washing regarding the accurate measurement of carbon emissions can precisely capture the extent of a firm's substantive efforts in relation to addressing its carbon footprint.

Firms may strategically engage in carbon washing to gain short-term benefits (Siano et al., 2017; Lee & Raschke, 2023). Financially, firms leverage ESG commitments and environmental performance to signal to investors (García-Meca et al., 2025; Peng et al., 2024); in this way, they may obtain short-term benefits, despite these commitments potentially carrying long-term risks (Berrone et al., 2017). Additionally, legal origin shifts the focus between shareholders' and stakeholders' interests while differentiating the strength of transparency, thereby varying the likelihood of deceptive environmental claims (Bui et al., 2020; Velte et al., 2020). However, few studies have investigated the impact of ownership structure (i.e. family businesses (FBs) vis-à-vis non-family businesses (NFBs)) on carbon-washing behavior. To bridge this gap, this study builds on and joins previous these conversations on the motivations and consequences of greenwashing, extending the current including focus to that greenwashing may assist businesses in gaining symbolic legitimacy in the short term (García-Meca et al., 2025; Lee & Raschke, 2023; Seele & Gatti, 2017) or establishing a temporary reputation, attracting more fleeting investors' attention

and gaining swift financial support from the capital market (Peng et al., 2024; Treepongkaruna, et al., 2024; Walker & Wan, 2012; Xu et al., 2022). Based on this, this study extends the existing literature on greenwashing to answer the following research questions: (1) Does carbon-washing exist in business practices? (2) Is this behavior affected by family ownership?

Drawing on legitimacy theory, all businesses are expected to implement environmental and social strategies, such as reducing their carbon footprint to align with public expectations and societal norms (Suchman, 1995; Zhang et al., 2023). However, meeting these expectations often requires costly investments, leading some firms to resort to carbon-washing as a symbolic strategy to claim legitimacy without substantive follow-through (Bui et al., 2020; Lee & Raschke, 2023). Signaling theory further explains that, under information asymmetry, firms may exaggerate environmental claims to enhance their societal image, regardless of potentially damaging long-term reputation (Connelly et al., 2011; Seele & Gatti, 2017). However, those with family ownership or family control in businesses (FBs) prioritize moral legitimacy and long-term goals tied to their social-emotional wealth (SEW), which encompasses family control, identification with the business, binding social relationships, emotional connections, and intergenerational succession (Berrone et al., 2010; Swab et al., 2020). Engaging in carbon-washing can undermine these SEW goals by damaging the family's reputation, eroding stakeholder trust, and jeopardizing intergenerational continuity. Deceptive environmental claims may weaken the emotional bonds FBs cultivate with their workforce and local communities, ultimately threatening their long-term legitimacy and sustainability. These values strongly emphasize reputation and stakeholder trust, making carbon-washing contradictory to FBs' objectives (Fan et al., 2021). Following this, we hypothesise that FBs are more likely to engage in genuine environmental efforts rather than symbolic compliance, suggesting they are less inclined to carbon-washing compared to NFBs.

To test our hypotheses, our study employed a sample containing 3,286 observations of the top-listed FBs worldwide matched with NFBs from 2009 to 2018. The results show evidence of carbon-washing across our sample firms, and FBs engage in less carbon-washing than NFBs. Furthermore, we identify distinct heterogeneity in these findings among FBs, including ESG reputation, implementation of the carbon emission trading scheme (ETS), jurisdictional context, and cultural influence. We also address concerns regarding selection bias, heterogeneity, and endogeneity.

We further examine the heterogeneity of carbon washing at the firm, industry, and institutional levels. To align with the intention of FBs' sustaining SEW, an investigation is first conducted to determine whether FBs' carbon-washing is primarily reduced for those within a higher ESG reputation cohort, driven by external expectations, legitimacy, and underlying reasons. In addition, the legitimacy concern of FBs makes them more compliant with regulatory requirements, thus reducing their propensity to carbon-wash. Next, the informal social norms of the country where FBs reside, such as the degree of stakeholder versus shareholder orientation and cultural influence, may also shape FBs' tendency to engage in carbon washing.

Our study makes several contributions to the literature. First, it joined the current conversation on greenwashing, with a specific focus on carbon-washing by examining the relationship between carbon emissions and environmental performance, as well as whether family ownership differentiates carbon-washing practices. Our finding of carbon-washing challenges the assumption that high environmental performance reflects genuine carbon-related practice and indicates superior environmental consideration. To support this, we classify distinct external influences from the firm level (i.e. from the third party's perspective of ESG reputation), industry-level (i.e., Higher- and Lower- carbon emission intensity industries), and institutional levels (i.e.

ETS implementation, jurisdictional and cultural influence) that drive corporate carbon-washing in FBs and NFBs differently. The findings from this study provide valuable insights into how businesses engage in carbon-washing within diverse contexts.

Second, under increasing public scrutiny, companies may be compelled to disclose only a partial picture of their environmental performance, potentially misleading stakeholders (Choi et al., 2024; Lee et al., 2023; Zhang, 2023). Our findings highlight inconsistencies in carbon reduction activities and environmental performance. Moreover, we acknowledge that different types of businesses can engage in carbon-washing to varying degrees, depending on their commitment to their communities. In detail, this study focuses on ownership structure, specifically the distinction between FBs and NFBs, to understand the phenomenon of carbon-washing. Our findings support the argument that FBs value their SEW and moral legitimacy and prioritise long-term reputation and family-business identity over short-term gains. Our study confirms that FBs actions reflect deeply embedded family values and stakeholder relationships. Our study also provides evidence of the difference between FBs and NFBs concerning carbon-washing from the SEW perspective; engaging in carbon-washing could jeopardise FBs' credibility, erode stakeholder trust, and threaten their long-term legacy. Consequently, FBs are less likely to engage in such symbolic environmental practices like carbon-washing.

Third, our research directly addresses the contradictory claim of positive corporate environmental performance and actual carbon emission behaviours, highlighting whether firms genuinely "walk the talk" or engage in symbolic environmentalism. While existing studies have focused on specific aspects of carbon emissions, such as Scope 1, Scope 2, or Scopes 1 and 2, our study examines the whole spectrum, including Scopes 1, 2, and 3. By doing so, this study provides a more comprehensive insight into whether firms are more inclined to "walk the talk" or merely

engage in symbolic environmentalism. Furthermore, we contribute by examining external influences, including ESG reputation, ETS, jurisdictional, and cultural contexts. We uncover patterns and discrepancies that reveal the extent of their environmental accountability beyond firm self-reporting data.

This study is organised as follows: Section 2 defines the theoretical framework and develops the hypotheses. Section 3 describes the methodology, while Sections 4 and 5 presents empirical results. Section 6 concludes the study with discussions, practical implications, limitations, and future research directions.

2. Literature review and hypothesis development

2.1 Literature Review (Joey didn't read it)

Carbon-washing, the practice of misleading stakeholders' perceptions about a firm's environmental performance by overstating actual carbon emission reductions, is primarily driven by financial incentives, legitimacy concerns, and societal expectations. Businesses prioritise profits; however, they also need to meet legitimate requirements. Under societal pressure, businesses may resort to carbon-washing as a strategic response to maintain their legitimacy (Siano et al., 2017; Lee & Raschke, 2023), and attract investors to gain financial support from capital markets (García-Meca, Martínez-Ferrero, & Hussain, 2025; Peng et al., 2024), even at the cost of long-term reputation (Seele & Gatti, 2017; Torelli et al., 2020; Treepongkaruna et al., 2024; Walker & Wan, 2012). Carbon-washing is also motivated by financial incentives. When business decision-makers realise that implementing carbon emissions reduction practices costs more than their returns, they may risk firms exaggerating environmental statements, regardless of the facts about carbon emissions (Peng et al., 2023). Firms' symbolic actions often mask their image of being good citizens while

avoiding substantive financial sacrifices to improve environmental performance (Walker & Wan, 2012). Additionally, social pressure from third parties, such as the media reporting on ESG controversies, may prompt them to adopt a symbolic environmental performance to maintain their public image (Long et al., 2024). Moreover, implementing ETS programs may incentivise businesses to carbon-wash to make themselves appear more aligned with national or international climate targets on overall emissions reduction (Grauel & Gotthardt, 2016; Tan et al., 2024). Moreover, regulations play a crucial role in shaping business operating environments. Jurisdictions with different stakeholder focuses, lower information transparency, and limited financial flexibility may provide fertile ground for carbon-washing (Bui, Houqe, & Zaman, 2020; Velte, Stawinoga, & Lueg, 2020). Also, cultural differences may influence carbon-washing behaviours, considering business long-or short- term orientation and uncertainty tolerances (Peng et al., 2023)

2.2 Theoretical framework for carbon-washing

This study draws on two theoretical perspectives, namely legitimacy theory and signalling theory, while incorporating SEW in the context of FBs, given the complexity of business motivations and behaviours. Legitimacy theory posits that businesses derive existence from society and are subject to legitimate demands to demonstrate that their behaviours are desirable, proper, or appropriate (Suchman, 1995). To meet legal and societal expectations, businesses must align their operations with societal norms, values, and beliefs (Bui et al., 2020; García-Meca et al., 2025; Zhang et al., 2023). According to this theory, organisations are expected to operate within the bounds of social value; otherwise, they will be deprived of their right to continued existence (Deegan & Rankin, 1996). Specifically, businesses devote themselves to different types of legitimacy, including cognitive, pragmatic, and moral. Cognitive legitimacy ensures the foundation of an organisation that survives in a societal context. Pragmatic legitimacy primarily concerns a business focusing on

the perceived benefits of business activities. Moral legitimacy counts on societal judgments of the right thing to do for society (Suchman, 1995; Seele & Gatti, 2017). Under legitimate pressure, businesses claim they obey societal norms and meet societal expectations, such as self-reporting a higher environmental performance and less carbon emissions (Bui et al., 2020). However, meeting these expectations can be costly, time-consuming, and uncertain, often requiring investments in new technologies and switching to alternative resources (Zhang, 2023). As a result, firms may resort to acquiring symbolic compliance through carbon-washing and claim legitimacy without substantive actions (Berrone et al., 2017; Bui et al., 2020; Lee & Raschke, 2023).

Signalling theory explains how firms communicate their environmental commitments to stakeholders in the presence of information asymmetry. Due to the disparity in information or knowledge between decision-makers (senders) and stakeholders (receivers), carbon-washing arises when firms exaggerate environmental claims in their communication with stakeholders without substantive action (Connelly et al., 2011; Walker &Wan, 2012). While such signalling behaviour may yield short-term benefits, it also increases the potential risk of destroying the business's long-term reputation and image (Seele & Gatti, 2017).

In this regard, carbon-washing functions as a communication strategy for businesses to assert their legitimacy. By conveying their environmental stance, firms seek to align with general public expectations, thus boosting their environmental legitimacy. Legitimacy pressure and information asymmetry may catalyse firms to carbon washing, exaggerating their environmental claims (Suchman, 1995; Torelli et al., 2020).

2.3 Carbon-washing in FBs vis-à-vis NFBs

Concerning the environment, prior studies suggest that firms with family control exhibit distinct attitudes, priorities and motivations in achieving legitimacy (Fan et al., 2021). Compared to FBs, NFBs are more motivated by pragmatic legitimacy that directs business activities towards profitability to satisfy the firm's key shareholders (Seele & Gatti, 2017). In contrast, FBs strongly focus on moral legitimacy, aiming to achieve long-term objectives in environmental activity and performance with the ultimate objective of intergenerational legacy (Xu et al., 2022; Yeh & Liao, 2024). As such, FBs particularly value their status of social-emotional wealth (SEW) (Choi et al., 2024; Fan et al., 2021; Yeh & Liao, 2024), FBs tend to minimize environmentally harmful practices, such as hazardous waste generation and air pollution, leading to a lower environmental footprint compared to NFBs. However, their strong commitment to preserving family assets and control often makes them more cautious in investment and innovation decisions (Lorenzen et al., 2024). Additionally, their deep emotional attachment to the business drives them to adopt policies that protect the family's image and reputation (Gomez-Mejia et al., 2025), which underpins their strategic decisions. SEW comprises the fundamental assumption of Family Identification intertwined with their business as a symbol of pride and legacy makes them highly sensitive to reputational risks; deeply Bind social relationships with local society, built on trust and reciprocity, discourages FBs engaging in carbon washing (Swab et al., 2020); strong Emotional ties stakeholders highlight the moral legitimacy in practice (Berrone et al., 2010)); and Renewal of family bonds through succession drives FBs strategic decisions often focus on genuine environmental initiatives, to ensure the FBs reputation endure for successors (Swab et al., 2020). Given these SEW dimensions, FBs adopt environmental strategies and policies not just for legitimacy but to safeguard their long-term reputation and intergenerational legacy. As maintaining

strong community relationships is a core priority, fostering trust and credibility is essential (Choi et al., 2024). However, carbon-washing as a symbolic strategy directly undermines these SEW values, posing a significant risk to FBs by eroding stakeholder trust and damaging their hard-earned reputation. Thus, we hypothesise that:

H1: Carbon-washing is lower in FBs than NFBs.

3 Data and research design

3.1 Sample and data

This study examines the top-listed family businesses[1] worldwide between 2009 and 2018. The selected sample period excludes the unexpected influence of the 2008 global financial crisis and the COVID-19 pandemic since 2019. Following prior studies, FBs are classified as businesses that are family-owned or controlled over multiple generations (e.g., Xu et al., 2022, 2023). The financial and carbon emission data are obtained from LSEG (formerly known as Refinitiv). The environmental performance data is retrieved from MorningStar, and the country-level institutional and cultural data are from the World Bank Open Data.

3.2 PSM approach to match FBs with NFBs

To alleviate the confounding effects of firm-specific factors between FBs and NFBs, we employ the propensity score matching (PSM 1:1) procedure to match all FBs in our sample with NFBs. PSM was used in the study to identify control observations from the listed NFBs (placed as a control group) for the FBs (set as the treatment group). PSM procedure has been applied to address

[1] The Global Family Business Index contains the 500 largest FBs globally. It was established by the Centre for Family Business at the University of St. Gallen, Switzerland, in cooperation with the Global Family Business Centre of Excellence at Ernst and Young Global Limited.

the main concerns of sample selection bias to mitigate the endogeneity and ensure adequate sensitivity of the regressions. The matching criteria for obtaining the control group include firm size, leverage, firm age, industry, geographical location and year. The dataset comprises the top 500 FBs from 2009 to 2018, excluding 257 private FBs. After accounting for 526 unavailable observations, 1,904 FBs observations were obtained before matching. Following 1:1 propensity score matching (PSM), with criteria of a 1:1 ratio with the nearest propensity score, the 3286 paired observations were attained. The sample selection procedure is shown in Figure 1.

INSERT FIGURE 1 HERE

3.3. Variables and definitions

Given that carbon emissions are considered one of the significant climate change factors and the leading trigger of environmental issues (Peng et al., 2024; Reepongkaruna et al., 2024), the dependent variable is constructed as Carbon Emission Intensity (CEI), measured as the total carbon dioxide (CO2) emissions in metric tons scaled by total sales. The total carbon emissions include direct CO_2 and CO_2 equivalent emissions (Scope 1); indirect CO2 and CO2 equivalent emissions (Scope 2); and total CO2 and CO2 equivalent emissions in tons (Scope 3).

The independent variable is environmental performance, measured by the Environmental Performance Score (ENP) obtained from Morningstar (Xu et al., 2022). This score assesses a company's environmental impact by evaluating its carbon emissions, resource efficiency, waste management practices, and sustainability policies. Morningstar derives ENP from company disclosures and third-party assessments, providing a standardised measure of environmental responsibility. A higher ENP indicates better environmental performance, while a lower score

suggests weaker sustainability efforts. In this study, ENP is used due to the study's focus on carbon-washing behaviour or strategy, observing whether stronger environmental performance aligns with reduced misleading sustainability claims

The multiple control variables (i.e. country-level, industry-level, and firm-level) are included in the analysis to enhance internal validity and limit the influence of confounding and other extraneous variables. First, the country-level economic and institutional factors influence a country's governance and policy implementation, which can have significant direct and indirect effects on environmental performance (Pent et al., 2024; Xu et al., 2022). The control for gross domestic product (GDP) is used as a country-level economic indicator, measured by GDP per capita, and higher GDP growth incentives may lead to higher carbon-washing (Kock & Min, 2026; Zhang, 2023). Both political stability (POS) and rule of law (ROL) are controlled to mitigate the diverse dimensions of institutional influences (Peng et al., 2024; Xu et al., 2022). POS specifies the consistency of the environment when implementing environmental policies. ROL reflects the transparency of regulatory enforcement. Second, industry dummies are used to control for industry fixed effects, the 2-digit standard industry classification (DSIC) that covers the entire economic activity (Xu et al., 2022). Third, the firm-level controls include the total return index (TRI), Property, Plant, and Equipment (PPE), leverage (LVRG), firm size (SIZE) and firm age (FMGE). TRI accounts as a financial metric that provides a comprehensive view of investment performance by including the effects of reinvesting dividends for investors assessing long-term gains (Svanberg et al., 2020). PPE measures corporate long-term physical assets, including buildings, machinery, and equipment (Peng et al., 2024). SIZE is measured as the natural logarithm of total assets. LVRG is calculated as the long-term liabilities to total assets (Xu et al., 2022). FMGE is controlled as the business incorporates (Yeh & Liao, 2024).

We incorporate dummy variables to investigate the differences across subgroups. A dummy of ownership types to distinguish the FBs and NFBs subsamples; FBs code as 1 and NFBs code as 0. A dummy of ESG reputation (DTRVC), measured by ESG controversies score indicates the exposure of the businesses to environmental, social, and governance controversies and adverse events reflected in global media. DTRVC is coded as 1 when the ESG controversies score is greater than the median, otherwise 0. Dummy of carbon emission trading scheme (DETS) implements country, DETS = 1 if the firm is from the ETS implemented country, otherwise, DETS = 0. A dummy of carbon intensity firm; HCBN=1 if carbon intensity exceeds the industry average, otherwise 0. JURI represents jurisdictional indicators, common law economies are coded as 1, and civil law economies are coded as 0.

Since environmental practices are shaped by corporate decision-making (Peng & Zhang, 2022), we investigate whether carbon-washing is influenced by the total corporate governance score or the gender diversity on the board and among executive members (Peng et al., 2024; Torelli et al., 2020).

The industry- and year-fixed effects are applied in the analysis.

3.4 Model specifications

To explore the existence of carbon-washing, we investigated the relationship between environmental scores and carbon emissions by testing the following model in our FBs and matching the NFBs sample.

$$\mathrm{CEI}_{it} = \beta_0 + \beta_1 \mathrm{ENP}_{it} + \Sigma\mathrm{controls} + \varepsilon_{it} \quad (1)$$

Where, CEI refers to the carbon emission intensity, which is constructed as the CO_2 Scopes 1, 2 and 3 emissions in metric tons over sales. ENP refers to the environmental performance scores,

and controls refer to the firm-level controls (TRI, PPE, SIZE, and FMGE), Industry-level controls (DSIC) and country-level controls (GDP, POS, and ROL). ε refers to error terms. All continuous variables are winsorised at the 1% and 99% levels to mitigate the potential influence of outliers. The variable of interest is β_1. A positive and significant β_1 is an indicator of carbon-washing that firms "talk" to stakeholders about their environmental performance and "walk" in higher carbon emissions (Peng et al., 2024; Siano et al., 2017). We then proceed to examine carbon-washing in FBs and NFBs by incorporating the FB dummy variable defined earlier and estimate the following multivariate regression,

$$\mathrm{CEI}_{it} = \beta_0 + \beta_1 \mathrm{ENP}_{it} + \beta_2 FB_{it} + \beta_3 \mathrm{ENP}_{it} \times FB_{it} + \Sigma\mathrm{controls} + \varepsilon_{it} \quad (2)$$

In Model (2), coefficients β_1 for ENP_{it} and β_3 for the interaction term $\mathrm{ENP}_{it} \times FB_{it}$ are our key considerations, indicating whether carbon-washing exists and the presence of differences in FBs and NFBs, respectively.

The hypothesis and the theoretical model are summarised in Figure 2.

INSERT FIGURE 2 HERE

4. Results

4.1 Sample distribution, descriptive statistics, and correlation analysis

Table 1 displays the average carbon emissions intensity (CEI), environmental performance scores (ENP) and sample distribution by country. Specifically, approximately 12.84% (211 of 1643), 10.10% (166 of 1643), and 9.13% (150 of 1643) of the observations are from the United States, France, and India, respectively. Conversely, Colombia, Norway, Singapore, Sweden and Portugal have 10 or fewer observations. For the CEI and ENP, France has the highest average CEI (2.33), and Singapore has the highest ENP (69.31%).

INSERT TABLE 1 HERE

Table 2 reports the sample variable statistics and the pairwise Pearson correlations of the key variables, including the mean (median) of CEI, which is 0.48 (0.00) in the FB dataset and 0.52 (0.00) in the NFB dataset; the mean (median) of ENP, which is 55.09 (54) in the FB dataset and 56.60 (56) in the NFB dataset. The control variables of TRI, PPE, SIZE, LVRG, FMGE and GDP in the paired observations of FB and NFB subsamples are displayed in Panels A and B. The correlation between the variables does not exceed 0.8. inflation factors (VIFs) of all model variables are less than 10. These suggested that multicollinearity issues are very unlikely to occur in the analysis.

INSERT TABLE 2 HERE

4.2 Multivariate regression results

Table 3 reports the results for Model (1). Column (1) presents the relation between environmental scores and carbon emissions intensity, and Column (2) presents the primary test of this relationship incorporating the ownership influence (Hypothesis 1). The positive coefficient of the relationship between ENP and CEI ($\beta_1 = 0.0125$, $t = 2.94$, $p < 0.01$, in Column (1)) shows that carbon-washing exists in the full sample, indicating that higher environmental scores result in higher carbon emissions, which means that carbon-washing is universal in businesses within our sample. This is consistent with the arguments from previous studies (i.e. Berrone et al., 2017; Torelli et al., 2020; Seele & Gatti, 2017; Peng et al., 2024). These findings indicate that firms portraying stronger environmental performance may, in reality, emit more carbon behind the scenes. In other words, businesses might leverage their environmental performance as a strategic tool to mislead societal perceptions and achieve their objectives. In addition, the positive coefficient of the relationship

between ENP and CEI ($\beta_1 = 0.0266$, $t = 4.22$, $p < 0.01$, in Column (2)) means that carbon-washing still exists while considering family involvement in business. In alignment with the interaction term of FBs × ENP ($\beta_3 = -0.0240$, $t = -3.12$, $p < 0.01$), the FBs have less intention to engage with carbon-washing. Thus, the H_1 is supported.

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4.3 Robustness tests and endogeneity

4.3.1 Addressing endogeneity

We use 2SLS to address the endogeneity issues in the primary test (see columns (1) and (2) in Table 4). We use the industry initial value (ENP_INV) as the instrumental variable for robust ENP. The significance levels and directional consistency of the results remain unchanged, indicating that the primary regression model is reliable and robust. This suggests that endogeneity is unlikely to bias the analysis, reinforcing the validity of our findings.

INSERT TABLE 4 HERE

4.3.2 Addition control for corporate governance

Three tests were conducted to evaluate and strengthen the empirical results. First, we considered corporate governance variables in the analysis. The quality of corporate governance affects business policy on carbon strategies and managerial decisions related to environmental risks and potentially associated costs (Bui et al., 2020; Choi & Luo, 2021; Velte et al., 2020; Zhang et al., 2023). We added the total corporate governance score (CGSC) and gender diversity scores for the executive (XVGD) and gender diversity scores for the board (BDGD), respectively. The results from the primary tests are held, including the carbon-washing in the pooled sample, and FBs still

are less likely to engage in carbon-washing. See Table 5 when adding CGCS, ENP (β_1=0.0306, t=4.48, $p < 0.01$) and the FBs ×ENP (β_3= –0.0265, t= – 3.26, $p < 0.01$). Adding XVGD (β_1=0.0225, t=3.33, $p < 0.01$), and FBs ×ENP (β_3= – 0.0235, t= – 2.88, $p < 0.01$) and BDGD (β_1=0.0272, t=4.03, $p < 0.01$), FBs ×ENP (β_3= – 0.0261, t= – 3.18, $p < 0.01$) respectively; These consistent results demonstrate the robustness of the findings and confirm the feasibility of the main tests, reinforcing the reliability of the analysis.

INSERT TABLE 5 HERE

5 Further analysis - Heterogeneity

The results of the main test show that, on average, carbon washing is lower in FBs compared to NFBs. A large body of research also indicates that FBs have distinct characteristics from NFBs in terms of governance, environmental, social, and governance (ESG) performance, and capital structure (Choi et al., 2024; Fan et al., 2021; Gómez-Mejía et al., 2025; Swab et al., 2020; Xu et al., 2023). We take a step further to investigate whether carbon-washing activity among FBs can be heterogeneous. Specifically, we examine the firm-level factor of ESG reputation, industry-level factor of carbon intensity, and country-level factors, including institutional factor of carbon emission trading scheme (ETS) implementation, jurisdictional considerations (i.e., stakeholder versus shareholder orientation) and cultural influences (i.e., long-term or short-term orientation, and uncertainty avoidance).

5.1 Heterogeneity at the firm level – ESG reputation

Given FBs' intense focus on SEW, particularly in preserving their reputation for intergenerational legacy, also, social pressure may dissimilate the corporate decisions, and induce

myopia and opportunism (Long et al., 2024; Velte et al., 2020). We propose that reputation plays a crucial role in deterring FBs from carbon-washing. At the same time, it acts as a pressure point that prompts NFBs to engage in symbolic environmental protection activity.

As previously discussed, FBs are inherently more driven by moral legitimacy than NFBs, as their long-term commitment to societal and environmental well-being is deeply tied to preserving their family reputation and community relationships. Carbon-washing presents a critical threat to FBs, for the reason that it can severely damage their social capital, including public trust and socioemotional wealth. To protect their legacy and uphold their moral legitimacy, FBs are more likely to take substantive actions to reduce their environmental impact rather than resorting to misleading sustainability claims. If exposed to unethical practices, the stakes are even higher for FBs with strong reputations. The reputational fallout for FBs could be devastating, further deterring them from engaging in carbon-washing. In contrast, NFBs often prioritise pragmatic legitimacy and may view a strong reputation as a double-edged sword. Instead of deterring them from carbon-washing, the pressure to maintain their public image may prompt them to focus on symbolic ESG efforts rather than meaningful environmental action (Long et al., 2024).

The results for the mechanism effect are displayed in Table 6. Columns (1) and (2) present the moderation effect of the reputation, measured by the ESG Controversies Score (TRVC). The positive coefficient of the relationship between ENP and CEI in higher TRVC (($\beta_1 = 0.0342$, $t = 4.67$, $p < 0.01$) means that carbon-washing still exists in a higher ESG Controversies Score subsample, with the interaction term of FBs × ENP ($\beta_3 = -0.0300$, $t = -3.39$, $p < 0.01$), indicates the FBs have less intention to engage with carbon-washing.

5.2 Heterogeneity at the industry level – Carbon Intensity

Given that firms in high-intensity carbon-emitting industries are subject to more stringent public scrutiny and regulatory oversight, we test whether our main results are consistent across firms in both high- and low-carbon-emitting industries. To do so, we divided our sample into sub-samples of high- and low-intensity carbon emissions industries based on the sample mean of carbon emissions and re-estimated the primary regression model. As shown in columns (3) and (4) of Table 4, they remain consistent across both subsamples. We observe reduced carbon-washing activity among FBs compared to NFBs, suggesting that the carbon-washing curbing effect of FBs remains consistent regardless of firms' carbon sensitivity.

INSERT TABLE 6 HERE

5.3 Heterogeneity at country-level

5.3.1 Carbon Emission Trading Scheme (ETS)

Various environmental regulations, including a carbon emission trading scheme (ETS), have been implemented to address carbon emissions and environmental performance (Dechezleprêtre et al., 2023; Tan et al., 2024). ETS programs aim to align firms with national or international climate targets by enforcing overall reductions in emissions, increasing information transparency, and discouraging carbon-intensive practices. However, while ETS frameworks aim to promote sustainable behaviour, their implementation may impose significant financial burdens on firms, requiring investment in new technologies and renewable energy. These costs can divert resources from profit-generating activities, potentially incentivising firms to engage in carbon-washing and creating the illusion of compliance without making substantive changes (Dechezleprêtre et al., 2023). NFBs, primarily driven by profit maximisation and managerial interests (Siano et al., 2017),

may be particularly susceptible to such strategies. The high costs and uncertain returns of adopting technology and renewable energy under ETS requirements may incentivise NFBs to engage in carbon-washing, creating a false appearance of compliance without incurring substantial expenses (Zhang, 2023). In contrast, FBs prioritise long-term relationships, socioemotional wealth, and reputation. Under the ETS regime, increased regulatory oversight and public scrutiny enhance transparency, thereby reducing information asymmetry between firms and stakeholders. For FBs, the heightened risk of non-compliance carries significant reputational consequences, potentially undermining their family legacy and stakeholder trust. Given their commitment to safeguarding SEW and maintaining community relationships, FBs are less likely to engage in carbon-washing compared to NFBs.

Columns (3) and (4) in Table 7 present another mechanism test on whether or not the carbon emission trading scheme is implemented. The insignificant negative coefficient of the relationship between ENP and CEI in the ETS non-implemented subsample (in Column (4), $\beta_1 = 0.0002$, $t = 0.01$, $p > 0.1$) means that no carbon-washing was found while ETS was not implemented. On the contrary, in Column (3), the positive coefficient of the relationship between ENP and CEI in ETS implemented subsample ($\beta_1 = 0.0411$, $t = 4.58$, $p < 0.01$) shows that carbon-washing subsists while ETS implemented, alongside the interaction term of FBs × ENP ($\beta_3 = -0.0345$, $t = -3.11$, $p < 0.01$), shows the FBs have less intention to engage with carbon-washing.

INSERT TABLE 7 HERE

5.3.2 Legal jurisdiction

Based on La Porta et al.'s (2000) assumption, legal origin acts as a solid contextual factor shaping organisational behaviour. Generally, the distinction between shareholder-focused governance in

common law systems and stakeholder-oriented governance in civil law systems significantly impacts the corporate perceptions on environmental performance (Kock & Min, 2016). Specifically, civil law countries exhibit greater government intervention (García-Meca et al., 2025) and less robust legal protection of minority shareholders (i.e. investors) since businesses primarily rely on bank-based financing (La Porta et al., 2000). In civil-law economies, regulations tend to emphasize compliance with specific rules rather than transparency and disclosure, leading to relatively high information asymmetry. Conversely, in common-law countries, which have a large proportion of minority investors, legal systems prioritize disclosure and transparency, imposing stringent legal requirements on business operations. As a result, the cost of corporate misconduct (e.g., carbon-washing) is relatively high (Grauel & Gotthardt, 2016). Therefore, we do not expect to observe widespread carbon-washing practices in common-law countries.

In civil-law countries, information asymmetry makes it challenging to oversee corporate practices (Connelly et al., 2011), potentially fostering an environment conducive to carbon-washing. Firms may exploit this gap by polluting first and addressing the consequences only later (Grauel & Gotthardt, 2016; Siano et al., 2017; Zhang, 2023). Having said that, the incentive to carbon-wash is lessened for FBs, which are bound by their belief in SEW and their long-term goal focuses.

Columns (5) and (6) in Table 7 present an extra mechanism effect test on where carbon-washing occurs due to the jurisdictional difference. The positive coefficient of the relationship between ENP and CEI in a Civil law context ($\beta1 = 0.0328$, $t = 3.60$, $p < 0.01$) means that carbon-washing exists in civil law subsample, with the interaction term of FBs ×ENP ($\beta3 = -0.0270$, $t = -2.51$, $p < 0.05$), shows the FBs have less intention to engage with carbon-washing. The insignificant coefficient of the relationship between ENP and CEI in a Common law context ($\beta1 =$

– 0.0020, t=–0.27, p > 0.1) means that no carbon-washing was found in the common law subsample. This additional test further proves that the external context provides a diverse environment for carbon-washing continued existence.

5.3.3 Cultural Influence

Hofstede et al. (2010) highlight that national culture determines individual values and social norms, and cultural significance serves as a critical normative isomorphic force in environmental responsibilities (Peng et al., 2024; Peng & Zhang, 2022; Ullah et al., 2022). Given that our international sample encompasses firms from different cultural contexts, it is essential to incorporate cultural dimensions to verify the carbon-washing behavioural difference between FBs and NFBs. Building on the premise that cultural norms affect decision-making towards climate change, business ethics and environmental priorities (Ullah et al., 2022), this study incorporates Hofstede's cultural index to explore how the cultural dimensions influence carbon washing behaviours. Specifically, we examine how the long- or short-term orientation (LST) and uncertainty avoidance index (UAI) shape carbon washing phenomena. The choice of LST and UAI is motivated by their impact on the governance dynamics and value orientations, as well as the emotions that influence the strategic processes in business (Fan et al., 2021; Peng et al., 2024). Moreover, the FBs and NFB respond to national cultural norms quite differently.

A. Long- vs. Short-term Orientation (LST)

The cultural dimension of the long- vs. short-term orientation (LST) reflects how societies prioritise future-oriented versus present-oriented vision (Hofstede et al., 2010; Ullah et al., 2022). To maintain legitimacy, businesses often align their practices with societal expectations. However, whether businesses adopt genuine strategies and actual actions to reduce carbon emissions or

merely engage in symbolic environmental efforts remains an open question. In a long-term focus cultural context, firms may face pressure to conform to legitimacy expectations. As a result, they might engage in extensive "talk" to maintain legitimacy rather than taking meaningful "walk" actions. However, compared to NFBs, FBs have more substantial reputational concerns and a greater focus on long-term organizational continuity, driven by SEW. This motivates them less likely to prioritize short-term success (Ullah et al., 2022). Therefore, we suggest that FBs are less likely to engage in carbon-washing in cultures with a stronger long-term orientation compared to NFBs.

The results ENP (β_1= –0.0226, t = 1.92, p<0.10 in Table 7 Column 5) show that carbon washing appeared in a higher LST cultural context, aligning with the negative and significant coefficient on FBs×ENP (β_3= –0.0299, t = –2.16, p<0.05), it is confirmed that carbon washing exists in a higher LST context and FBs are less likely to engage to it than NFBs, which is consistent with our baseline results.

B. Uncertainty avoidance index (UAI)

The UAI measures the extent to which societies tolerate uncertainty and ambiguity (Fan et al., 2021; Hofstede, 2010). A higher UAI cultural context provides straighter structured rules, stricter societal expectations, and higher regulatory pressures. As a result, businesses may feel obliged to exhibit their environmental responsibility to maintain legitimacy in such a context, even if they don't have actual carbon emissions strategies in practice. In such contexts, businesses may rely on signalling strategies to project strong environmental performance, leading to an increased likelihood of carbon-washing. Since profit maximization remains a core business objective, managers may prioritize pragmatic legitimacy and reputational benefits over substantive

environmental commitments in high UAI settings. However, FBs, which tend to be more risk-averse, are less likely to engage in deceptive environmental practices. Their long-term strategic orientation and commitment to SEW motivate them to pursue genuine sustainability efforts rather than relying on superficial signals of environmental performance (Fan et al., 2021). FBs in high UAI cultures are, therefore, more inclined to align with moral legitimacy by integrating sustainable practices into their business models, rather than engaging in carbon-washing. For these reasons, we expect carbon-washing to be less prevalent among FBs than among NFBs in high UAI cultural contexts.

Table 7, columns (7) and (8) represent the results for the country-level cultural moderation on the relationship between ENP and CEI, respectively. We use subgroups to analyse the UAI moderate carbon washing. In column (8), the negative and significant coefficient on FBs×ENP ($\beta 3 = -0.0299$, $t = -2.39$, $p<0.05$) is consistent with our baseline results on decreased carbon-washing in FBs than NFBs. Further, no carbon washing was found in the lower UAI context.

6. Discussion and Conclusion

6.1 Discussion

Drawing on signalling theory, legitimacy theory, and SEW, this study explores whether carbon-washing exists and is affected by ownership structure (FB vs NFBs). A further understanding of carbon-washing phenomena was provided via three levels of moderators, including the firm-level of ESG reputation, the industry-level of carbon-intensity, and the country-level of ETS, jurisdictional regime and the national cultural context of Long- vs. Short-term Orientation (LST) and Uncertainty avoidance index (UAI). Our findings indicate that businesses focusing on long-term success, such as FBs, are less likely to engage in carbon-washing.

The results from the PSM matched sample show that environmental performance has a positive impact on carbon emissions intensity, suggesting a general tendency for carbon-washing among firms that signal higher environmental performance while simultaneously experiencing a higher intensity of carbon emissions. Furthermore, the results indicate that FBs may engage in carbon-washing, but have a lower intention to do so, potentially due to their SEW, which emphasizes a longer-term business orientation aimed at passing the business on to future generations. Additionally, SEW encourages FBs to protect their reputation and legacy, discouraging carbon-washing, as it may lead to reputational risks that ultimately damage the business's reputation, reflecting on the family name and harming the business's legacy and standing in the community. FBs prefer to uphold solid and long-standing relationships with stakeholders, which motivates them to genuinely engage in sustainable practices to maintain legitimacy within their communities rather than signalling only.

The results from the three specific mechanisms of reputation, carbon ETS implementation, and jurisdiction confirm the presence of carbon-washing. Regarding the mechanism of reputation, carbon-washing occurs in businesses with a higher controversy score, where firms were identified with fewer risks and more substantial capabilities. From the third-party perspective, businesses with higher controversy scores might favour media coverage and paint their public image, involving signal compliance with societal norms, leveraging carbon emission efforts and their environmental performance, which might mask deficiencies in their environmental practices, such as higher carbon emissions. Thus, they can protect the legitimacy in the eyes of the public. However, FBs have long-term considerations of preserving the family reputation and business legacy across generations. They are typically more cautious about their environmental claims, so they are less likely to engage with carbon-washing, which can damage trust and public image in

the long run. Second, in ETS-implemented countries, where firms face intense legitimacy pressures, they attempt to improve their image, which drives carbon-washing. Our results suggest that businesses in an ETS setting may use symbolic communication, selectively highlight positive information, and suppress negative news, rather than making substantive environmental improvements to mitigate financial harms. In contrast, ETS regulatory implementation spurs businesses to share favourable information selectively, focusing on trust and stakeholder engagement rather than compliance. Without regulatory pressure, they are less inclined to engage in carbon-washing. In addition, FBs have a long-term focus and close ties with local communities; they prefer substantive environmental engagement during ETS implementation and appear less likely to engage in carbon-washing. Third, legal jurisdiction constitutes a critical channel for investors to understand the possibility of carbon-washing behaviours. In common law systems, the solid legal environment reduces the need for symbolic signalling to maintain legitimacy; firms face stricter transparency requirements in a context with less information asymmetry, which reduces the potential for carbon-washing. In contrast, carbon-washing occurs in less transparent and higher information asymmetry environments of civil law jurisdictions, where businesses may use green credentials to deceive stakeholder trust under weaker transparency requirements. However, this is partially the case where FBs perceive reputational or legitimacy risks in weaker legal protection; they are more cautious about substantive environmental actions to protect SEW and avoid accusations of carbon-washing.

Furthermore, when considering LST and UAI as country-level cultural moderators, the results reveal that carbon washing is more prevalent in contexts with higher levels of LST and UAI. Additionally, FBs demonstrate a lower inclination to engage in carbon washing than NFBs. This suggests that long-term considerations and higher uncertainty avoidance contexts create an

atmosphere where decision-makers focus on the business's future and tolerate uncertainty and ambiguity in order to maintain legitimacy. Specifically, FBs prioritise genuine reductions in carbon emissions and care about environmental performance to enhance their reputation rather than symbolic gestures. FBs may pay more attention to a solid commitment to reducing carbon emissions, particularly in enjoying specific dimensions, such as identifying family and business with an Emotional connection to SEW and reinforcing their dedication to authentic environmental action. In theory, moral legitimacy can also influence behaviour within FBs beyond pragmatic legitimacy. The influence of LST or UAI encourages decision-makers in FBs to prioritise environmental initiatives over symbolic actions, potentially resulting in carbon-washing deductions, especially when performance visibility is crucial for maintaining their reputation.

6.2 Conclusion

The increasing public concern about climate change has imposed tremendous institutional pressure on businesses. Therefore, firms seek ways to demonstrate that they have made an effort to reduce carbon emissions in order to meet public expectations. This study aimed to investigate the presence of carbon-washing and the impact of ownership structure (FBs vs NFBs). Additionally, the analysis was further tested on the influences of ESG reputation, ETS, jurisdiction and culture. In addition, the moderation of the national cultural context of LST and UAI. Drawing on signalling theory, legitimacy theory, and socioemotional wealth (SEW), our findings provide insights into how businesses may mislead stakeholders by presenting high environmental performance information that is decoupled from actual carbon emissions. Our analysis demonstrates notable differences in carbon-washing behaviour between FBs and NFBs. FBs exhibit less inclination to carbon-washing than NFBs. This is due to their focus on SEW and inter-generational legacy. In contrast, the NFBs are more likely to use symbolic communication strategies to influence

stakeholder perceptions and enhance corporate legitimacy. As FBs have long-term goals, they are more likely to bear the costly societal initiatives, viewing environmental investments as beneficial for future generations. FBs responsiveness towards reputational risk and legitimacy pressures prompts them to adhere more closely to social norms and implement environmentally protective measures. Our results remain the same across the ETS implemented sample, higher ESG reputation, civil law contexts, and across all carbon emission intensity industries.

Our findings offer valuable recommendations for stakeholders, particularly policymakers and investors, emphasising a holistic perspective rather than relying solely on partial metrics. To effectively mitigate carbon-washing and carbon-washing practices and ensure accurate corporate environmental representations, policymakers should adopt a holistic approach to evaluating models by considering both reported environmental performance and actual carbon emissions. Policymakers should introduce independent audits of carbon emissions to ensure the reported data is accurate, reliable, and accountable. Policymakers should tailor regulations that align with a country's specific cultural characteristics that influence managers' ethical decision-making. Investors can use these insights to more effectively detect and assess potential carbon-washing strategies. They should consider that the higher controversy scores from the third party may indicate carbon-washing, and they should account for differences in ownership structures and jurisdictional contexts. In this way, they can more accurately identify misleading practices. Thus, enhanced understanding enables a more strategic allocation of resources, time, and attention.

The investigation may be subject to limitations, offering potential directions for future research. This study primarily focuses on top-listed FBs; however, tackling climate change requires a global approach, including studies on carbon-washing among small- and medium-sized enterprises (SMEs). Additionally, our results show the moderating effects of LST and UAI; future

research may need to explore a thorough picture of why and how cultural dimensions affect environmental performance to further support the investigation of carbon-washing phenomena.

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Figure 1 Sample selection procedure

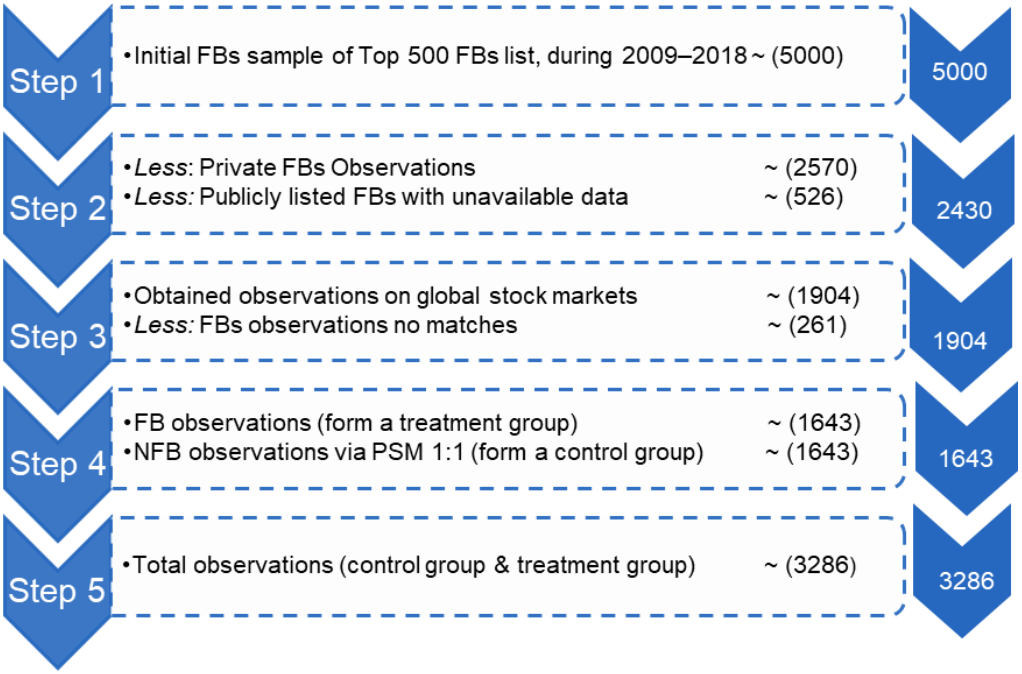
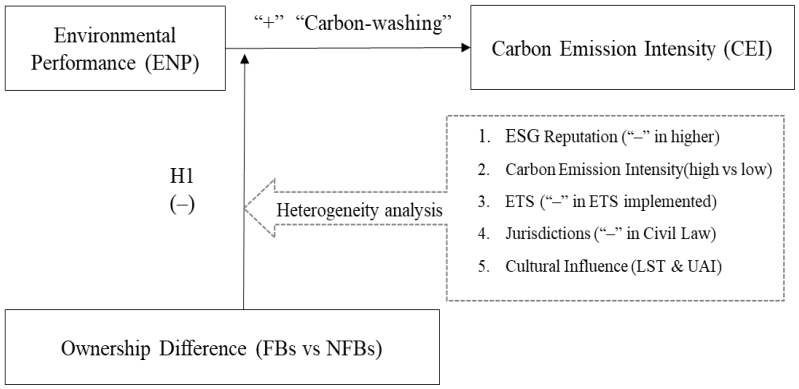


Figure 2 Theoretical model



Note: Figure 2 shows the theoretical model in this study. FB = family business; NFB = non–family business

Table 1 Carbon emissions and environmental scores by country

Region	N	CEI	ENP
Belgium	46	0.06	65.12
Brazil	54	0.63	52.54
Canada	60	0.07	59.80
Colombia	10	0.00	32.46
China	98	0.02	38.91
Germany	116	0.35	64.51
Spain	40	0.20	65.65
France	166	2.33	59.05
Greece	20	0.43	60.45
Netherlands	29	0.05	56.35
Italy	58	0.04	48.20
Indonesia	19	0.00	33.48
India	150	0.46	58.47
Israel	20	0.25	51.31
Japan	40	0.03	48.83
Hong Kong	80	0.55	52.21
South Korea	67	0.01	51.95
Malaysia	30	0.42	46.89
Mexico	95	0.45	56.12
Norway	10	0.00	44.84
Portugal	7	0.06	68.45
Philippines	17	0.69	43.68
Russia	49	0.26	39.69
Switzerland	70	0.01	61.26
Singapore	10	0.18	69.31
Turkey	20	0.03	38.32
Taiwan	20	1.17	40.10
US	211	0.24	43.22
UK	21	0.28	54.22
Sweden	10	0.33	60.23
Total	1,643	0.48	55.09

Note: See Appendix A for the variables' definitions: CEI=carbon emission intensity, ENP= Environmental Performance

Table 2 Descriptive statistics, correlations and variance inflation factors (VIF) for variables[a,b,c]

Panel A:												
	FBs Sample						**NFBs Sample (obtained via PSM)**					
	N	**Mean**	**SD**	**P25**	**Medi**	**P75**	**N**	**Mean**	**SD**	**P25**	**Medi**	**P75**
CEI	1618	0.48	1.93	0.00	0.00	0.09	1578	0.52	2.07	0.00	0.00	0.05
ENP	1209	55.09	14.26	44.00	54.00	65.00	912	56.60	13.49	46.00	56.00	66.01
TRI	1616	5.94	3.03	3.78	6.15	7.92	1524	5.29	3.00	3.04	5.46	7.40
PPE	1629	14.49	1.48	13.64	14.52	15.39	1584	14.18	2.05	12.93	14.34	15.7
SIZE	1632	16.14	1.11	15.36	15.96	16.86	1624	15.99	1.65	14.85	16.05	17.28
LVRG	1631	0.19	0.14	0.06	0.19	0.29	1587	0.20	0.17	0.06	0.18	0.28
FMGE	1643	44.00	32.62	18.00	41.00	57.00	1643	47.76	37.96	18.00	37.00	67.00
GDP	1643	28.36	1.21	27.73	28.36	28.89	1643	28.37	1.21	27.74	28.35	28.94

Panel B: Pairwise correlations and VIF									
Variables	VIF	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) CEI	1.00	1.000							
(2) ENP	1.21	0.142***	1.000						
(3) TRI	1.20	0.122***	0.312***	1.000					
(4) PPE	1.95	0.161***	0.169***	0.201***	1.000				
(5) SIZE	1.92	0.153***	0.213***	0.247***	0.709***	1.000			
(6) LVRG	1.11	0.068***	–0.009	0.059***	0.299***	0.175***	1.000		
(7) FMGE	1.15	0.047***	0.242***	0.294***	0.130***	0.163***	–0.025	1.000	
(8) GDP	1.09	0.008	0.038*	0.185***	–0.038**	–0.032*	0.043**	–0.076***	1.000

Note:

[a] See Appendix for the variables' definitions; FB = family business; NFB = non–family business. N=observations, SD= Standard Deviation, Medi = Mediation, P25 and P75= 25th and 75th percentile, respectively.

[b] No variance inflation factor value in this study exceeds 10 (Gujarati, 2003), and no correlations are above 0.8.

[c] *** if $p < 0.01$, ** if $p < 0.05$, * if $p < 0.1$, two–tailed

Table 3 Baseline Results[a,b,c]

	(1)	(2)
	Treated and controlled Sample using PSM	
VARIABLES	CEI	CEI
ENP[β_1]	0.0125***	0.0266***
	(2.94)	(4.22)
FBs[β_2]		1.1327**
		(2.55)
FBs×ENP[β_3]		–0.0240***
		(–3.12)
TRI	0.0175	0.0230
	(0.79)	(1.04)
PPE	–0.0132	–0.0126
	(–0.22)	(–0.21)
SIZE	0.2032***	0.1879**
	(2.66)	(2.45)
LVRG	0.8237**	0.8101**
	(2.04)	(2.01)
FMGE	0.0010	0.0012
	(0.64)	(0.73)
GDP	–0.0150	–0.0260
	(–0.33)	(–0.57)
POS	–0.6726***	–0.6980***
	(–4.71)	(–4.89)
ROL	0.5302***	0.5545***
	(3.88)	(4.05)
Industry Fixed Effect	YES	YES
Year Fixed Effect	YES	YES
Constant	–1.5515	–1.2332
	(–1.02)	(–0.80)
Observations	1,974	1,974
Adjusted R^2	0.0797	0.0851
F–statistic	7.830***	7.801***

Note:

a See Appendix for the variables' definitions; The estimated coefficient is displayed on the first row; the t–value of significance is in parentheses.

b All of the continuous variables are winsorised at the 1st and 99th percentiles to mitigate the possibility of outliers effect.

c All tests are two–tailed, *** if $p < 0.01$, ** if $p < 0.05$, * if $p < 0.1$.

Table 4 Endogeneity - 2SLS - IV Approach[a,b,c]

	(1)	(2)
VARIABLES	1st Stage ENP	2nd Stage CEI
$\widehat{ENP}$		0.0542***
		(5.80)
ENP_INV (IV)	0.5052***	
	(23.39)	
FBs×ENP[β_3]	0.0722***	–0.0086***
	(8.63)	(–4.16)
TRI	0.6766***	–0.0109
	(6.73)	(–0.46)
PPE	–0.5709**	0.0119
	(–2.25)	(0.20)
SIZE	2.1497***	0.0623
	(6.51)	(0.75)
LVRG	–3.8116**	0.9573**
	(–2.05)	(2.30)
FMGE	0.0420***	–0.0011
	(5.69)	(–0.64)
GDP	–0.1768	–0.0148
	(–0.85)	(–0.32)
POS	–0.6803	–0.6030***
	(–1.04)	(–4.13)
ROL	3.5637***	0.3898***
	(5.73)	(2.74)
Industry Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
Constant	–12.1303*	–3.0283*
	(–1.69)	(–1.92)
Observations	1,994	1,963
Adjusted R^2	0.4405	0.0570
Wald χ^2	1569***	219.5***
Prob > chi^2	0.0000	0.0000

Note:

[a] See Appendix for the variables' definitions; ENP_INV=industry initial value.

[b] All of the continuous variables are winsorised at the 1st and 99th percentiles, to mitigate the possibility of outliers effect.

[c] The estimated coefficient displays on the first row; the *t*–value of significance is in parentheses; All tests are two–tailed, *** if p < 0.01, ** if p < 0.05, * if p < 0.1.

Table 5 Additional control for corporate governance[a,b,c]

VARIABLES	(1) CEI	(2) CEI	(3) CEI
ENP[β_1]	0.0306***	0.0225***	0.0272***
	(4.48)	(3.33)	(4.03)
FBs[β_2]	1.2514***	1.0937**	1.2481***
	(2.63)	(2.30)	(2.61)
FBs×ENP[β_3]	–0.0265***	–0.0235***	–0.0261***
	(–3.26)	(–2.88)	(–3.18)
CGSC	–0.0064**		
	(–2.35)		
BDGD		0.0287***	
		(5.50)	
XVGD			–0.0059
			(–1.06)
TRI	0.0110	–0.0090	0.0193
	(0.46)	(–0.37)	(0.79)
PPE	0.0056	0.0110	–0.0060
	(0.09)	(0.18)	(–0.10)
SIZE	0.2052**	0.1658**	0.1996**
	(2.45)	(1.98)	(2.36)
LVRG	0.8294*	0.9638**	0.7969*
	(1.93)	(2.24)	(1.84)
FMGE	0.0010	0.0007	0.0010
	(0.60)	(0.43)	(0.56)
GDP	–0.0200	–0.0525	–0.0240
	(–0.42)	(–1.10)	(–0.50)
POS	–0.7403***	–0.5860***	–0.7292***
	(–4.90)	(–3.84)	(–4.81)
ROL	0.5744***	0.3859***	0.5856***
	(3.97)	(2.60)	(4.03)
Industry Fixed Effect	YES	YES	YES
Year Fixed Effect	YES	YES	YES
Constant	–3.8172**	–2.4443	–3.5659**
	(–2.27)	(–1.45)	(–2.12)
Observations	1,843	1,835	1,837
Adjusted R^2	0.0960	0.108	0.0936
F–statistic	7.988***	8.926***	7.775***

Note:
Add additional Corporate Governance variables, CGSC; BDGD, and XVGD, respectively.
[a] See Appendix for the variables' definitions; The estimated coefficient displays on the first row; the *t*–value of significance is in parentheses.
[b] All of the continuous variables are winsorised at the 1st and 99th percentiles, to mitigate the possibility of outliers effect.
[c] All tests are two–tailed, *** if p < 0.01, ** if p < 0.05, * if p < 0.1.

Table 6 Results of ESG Reputation and Carbon-Intensity Industry Splits [a,b,c,d]

	(1)	(2)	(3)	(4)
	ESG Reputations		Carbon-Intensity Industry Split	
VARIABLES	DTRVC=1 CEI	DTRVC=0 CEI	HCBN=1 CEI	HCBN=0 CEI
ENP[β_1]	0.0372***	0.0138	0.0307***	0.0208**
	(4.46)	(1.31)	(3.64)	(2.26)
FBs[β_2]	1.4373**	0.8964	1.0502*	1.5290**
	(2.56)	(1.10)	(1.73)	(2.42)
FBs×ENP[β_3]	–0.0318***	–0.0184	–0.0260**	–0.0235**
	(–3.15)	(–1.38)	(–2.53)	(–2.05)
TRI	–0.0209	0.0870**	0.0485	–0.0178
	(–0.79)	(2.07)	(1.52)	(–0.61)
PPE	0.0088	–0.0395	0.0386	–0.0719
	(0.12)	(–0.35)	(0.46)	(–0.92)
SIZE	0.1787*	0.2441*	0.1109	0.3186***
	(1.75)	(1.85)	(1.04)	(2.96)
LVRG	1.0772**	0.1028	0.9854*	0.1647
	(2.14)	(0.15)	(1.87)	(0.27)
FMGE	0.0011	0.0023	0.0002	0.0032
	(0.54)	(0.85)	(0.07)	(1.30)
GDP	–0.0185	–0.0360	–0.0149	–0.0867
	(–0.34)	(–0.41)	(–0.25)	(–1.30)
POS	–0.7325***	–0.6750***	–0.5413***	–1.3038***
	(–4.06)	(–2.78)	(–3.08)	(–4.94)
ROL	0.6049***	0.5252**	0.3725**	1.2496***
	(3.65)	(2.11)	(2.23)	(4.85)
Industry Fixed Effect	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES
Constant	–1.0783	–2.2861	–2.7111	–3.3356
	(–0.51)	(–0.83)	(–1.33)	(–1.43)
Observations	1,257	717	1,330	644
Adjusted R^2	0.0982	0.0253	0.1001	0.1107
Wald χ^2	8.48***		0.52	
Prob > chi^2	0.0000		0.4722	

Note:
a See Appendix for the variables' definitions; DTRVC=1 indicates higher ESG reputation, otherwise 0; HCBN=1 if carbon intensity exceeds the industry average, otherwise 0.
b The estimated coefficient is on the first row; the t-value of significance is in parentheses.
c All of the continuous variables are winsorised at the 1st and 99th percentiles, to mitigate the possibility of outliers effect.
d All tests are two–tailed, *** if p < 0.01, ** if p < 0.05, * if p < 0.1.

Table 7 Country–Level Influence[a,b,c,d]

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ETS implementation		Jurisdictions		Long– or short–term Orientation		Uncertainty Avoidance	
VARIABLES	DETS=1 CEI	DETS=0 CEI	JURI=1 CEI	JURI=0 CEI	DLST=0 CEI	DLST=1 CEI	DUAI=0 CEI	DUAI=1 CEI
ENP[β_1]	0.0411***	0.0002	–0.0020	0.0328***	–0.0033	0.0226*	–0.0033	0.0341***
	(4.58)	(0.01)	(–0.27)	(3.60)	(–0.73)	(1.92)	(–0.59)	(3.26)
FBs[β_2]	1.6697**	–0.8323*	–0.5040	1.1414*	–.2285	.8068	–.3178	1.2924*
	(2.51)	(–1.82)	(–1.06)	(1.78)	(–.76)	(0.97)	(–0.86)	(1.72)
FBs×ENP[β_3]	–0.0345***	0.0149*	0.0071	–0.0270**	0.0067	–0.0299**	0.0045	–0.0299**
	(–3.11)	(1.73)	(0.83)	(–2.51)	(1.25)	(–2.16)	(0.68)	(–2.39)
TRI	0.0621**	–0.0444*	–0.0619**	0.1021***	–0.0285*	0.1510***	–0.0486**	0.1160***
	(2.01)	(–1.84)	(–2.18)	(3.35)	(–1.70)	(3.48)	(–2.02)	(3.35)
PPE	–0.1107	0.1302**	0.2333***	0.0155	0.1260***	0.0869	0.1934***	0.0448
	(–1.31)	(2.01)	(3.38)	(0.19)	(3.21)	(0.72)	(3.53)	(0.49)
SIZE	0.1701	0.1472*	0.1601*	0.0363	0.1736***	0.0538	0.0950	0.0610
	(1.61)	(1.67)	(1.74)	(0.36)	(3.09)	(0.37)	(1.34)	(0.50)
LVRG	0.1532	0.4839	–0.0596	1.1526**	0.3317	0.5627	0.2002	1.3483**
	(0.28)	(1.01)	(–0.14)	(2.07)	(1.24)	(0.68)	(0.57)	(2.06)
FMGE	0.0018	0.0002	–0.0012	0.0017	0.0020*	–0.0020	0.0007	–0.0009
	(0.88)	(0.08)	(–0.52)	(0.84)	(1.66)	(–0.77)	(0.43)	(–0.37)
GDP	–0.2283***	–0.0473	0.0151	0.2874***	0.0135	–0.0738	–0.0523	0.3730***
	(–2.96)	(–0.73)	(0.37)	(3.24)	(0.41)	(–0.57)	(–1.29)	(3.00)
POS	–2.4640***	–0.0625	0.1963	–1.5876***	–0.1293	–1.7560***	–0.5957***	–0.8142***
	(–8.52)	(–0.51)	(1.16)	(–6.68)	(–1.34)	(–4.25)	(–3.54)	(–3.43)
ROL	1.3730***	0.2265*	–0.0660	1.1195***	0.1153	1.1760**	0.1641	1.4360***
	(5.58)	(1.69)	(–0.31)	(5.70)	(0.88)	(2.16)	(0.63)	(4.20)
Industry Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Year Fixed Effect	YES	YES	YES	YES	YES	YES	YES	YES
Constant	8.0110***	–2.7190	–5.3262***	–4.2771	–4.6579***	–0.7524	–2.5135*	–13.6025***
	(3.21)	(–1.32)	(–3.37)	(–1.63)	(–4.07)	(–0.19)	(–1.90)	(–3.70)
Observations	1,267	707	748	1,226	1,059	915	949	1,025
Adjusted R^2	0.186	0.100	0.154	0.238	0.154	0.273	0.139	0.275
F–statistic	11.70***	3.917***	6.026***	15.17***	7.873***	13.28***	6.487***	14.90***

Note:

[a] See Appendix for the variables' definitions; DETS=1 indicates countries implemented ETS, otherwise 0; JURI=1 indicates common law countries, otherwise 0; DLST=1 indicates long- term Orientation, DUAI=1 indicates a higher Uncertainty Avoidance.

[b] All continuous variables are winsorised at the 1st and 99th percentiles, to mitigate the possibility of outliers effect.

[c] Since the ETS was implemented in China and the UK in 2021, outside the data sample range of 2009 to 2018, observation from these countries are excluded from the analysis.

[d]The estimated coefficient displays on the first row; the t–value of significance is in parentheses; All tests are two–tailed, *** if $p < 0.01$, ** if $p < 0.05$, * if $p < 0.1$.

Appendix A Definitions of variables

Variable	Definitions and Measurements	References
ENP	Environmental performance score	From MorningStar
CEI	Carbon emission intensity, is calculated as the total carbon emission (scope1+scope2+scope3) to total sale,	Peng et al., 2024
TRI	Total return index, a financial metric used to measure the performance of an index or asset that accounts for both price changes and dividends	Svanberg et al., 2020
SIZE	Firm size, calculated as the natural logarithm of total assets	Xu et al., 2023
LVRG	Firm leverage, calculated as the natural logarithm of the ratio of long–term debt to total asset	Shan et al. (2019)
FMGE	firm age, calculated as the number of years since a firm incorporated	Yeh &Liao, 2024
PPE	Property, Plant and Equipment	Peng et al., 2024
POS	Political Stability and Absence of Violence/Terrorism, indicates the perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism	Peng et al., 2024
ROL	Rule of Law, indicates how the rule of law is experienced and perceived	Peng et al., 2024
DLST	Dummy of long– or short-term orientation. DLST=1 if the score is greater than the median; otherwise, 0.	Peng et al., 2024
DUAI	Dummy of uncertainty avoidance. DUAI=1 if avoidance score is greater than the median; otherwise, 0.	Peng et al., 2024
JURI	Dummy of jurisdictions, JURI=1 for the firm in common law countries; JURI=0 for the firm in civil law countries	García-Meca et al., 2025; Xu et al., 2022
CGSC	Governance score, obtained from Refinitiv ESG	Xu et al., 2022
XVGD	Executive Members Gender Diversity, Percentage of female executive members.	Xu et al., 2022
BDGD	Value of Board Structure/Board Diversity	Velte et al., 2020
DTRVC	Dummy of ESG controversies score. The ESG controversies category score assesses a company's exposure to environmental, social, and governance-related controversies and adverse events reported in global media. DTRVC=1 if TRVC is greater than the Median, otherwise 0.	Svanberg et al., 2022
GDP	GDP per capita, used as country-level economic CV, Controls for the national wealth that reflects a national economic development, calculated as the natural logarithm value of GDP	Kock &Min, 2016; Zhang, 2023
DSIC	2-Digit Standard Industrial Classification OSHA, 2018	Xu et al., 2022
YEAR	The firms' operational year of 2009–2018	Xu et al., 2022
DETS	Dummy of carbon emission trading scheme, DETS = 1 if the firm is from the ETS implemented country, otherwise, DETS = 0	Dechezleprêtre et al., 2023
ENP_INV	The initial value of the environmental performance score	Svanberg et al., 2022

Appendix B Propensity scores matching procedures

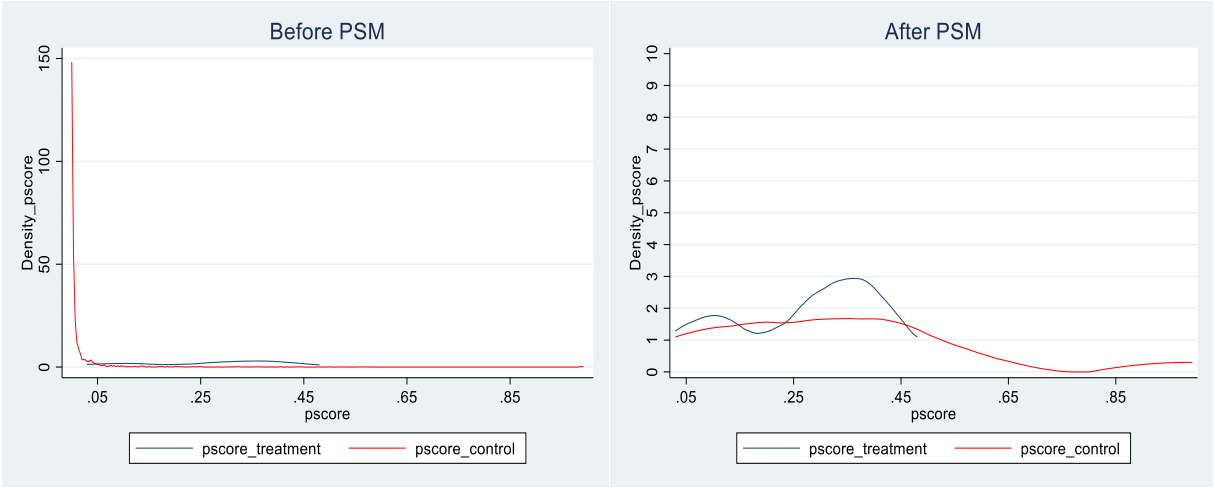
Panel A: First–step logit regression estimates

Variable	First–step FBs Dummy
SIZE	–0.452**(–2.54)
LVRG	–2.001(–11.85)
FMAG	0.023*(1.85)
Industry FE	Yes
Year FE	Yes
Observations	160

Panel B: Second–step conditional independence assumption (CIA)

	Unmatched	Mean		% reduced		*t*–test	
Variable	Matched	Treated	Control	%bias	|bias|	*t*	*P* >|*t*|
SIZE	U	16.494	16.859	–28.6		–1.81	0.072
	M	16.520	16.657	–10.8	62.3	–0.65	0.518
LVRG	U	0.164	0.204	–24.2		–1.53	0.128
	M	0.167	0.170	–2.1	91.1	–0.22	0.829
FMAG	U	26.375	23.800	16.7		1.06	0.292
	M	25.284	24.836	2.9	82.6	0.17	0.865

Panel C: Kernel density estimates plots (common support)



Note:
Using FBs in Hong Kong as an example to demonstrate the PSM procedure. Panel A reports the first-step logit model results. The numerical value represents the estimated coefficient, and the numerical value in parentheses represents the significance of the z–value. Panel B reports the Second-step conditional independence assumption (CIA); Panel C presents the Kernel density estimates plots (common support) before and after PSM. See Appendix 1 for the definitions of the variables: FB = family business.
*if $p < .10$; **if $p < .05$; ***if $p < .01$. All tests are two–tailed.