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Does Carbon Performance Mediate the Link Between ESG Performance and Corporate Tax Avoidance?

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Abstract

This study examines the relationship between environmental, social, and governance (ESG) performance and corporate tax avoidance and investigates whether carbon performance serves as a transmission mechanism linking the two. Using an international panel of 15,840 firm-year observations from 1584 listed firms across 52 countries during the 2015–2023 period, the analysis employs random-effects generalized least squares (GLS), mediation analysis, instrumental variable (2SLS), and System Generalized Method of Moments (GMM) estimations. The results show that stronger ESG performance is associated with lower book–tax differences (BTD), indicating reduced corporate tax avoidance. Carbon performance is positively associated with ESG performance and partially mediates the ESG–tax avoidance relationship, explaining approximately 14% of the total effect. Additional analyses reveal that the Environmental pillar is the primary driver of this mediation mechanism, while the relationship is stronger among firms with higher governance quality. The findings remain robust to alternative measures of tax avoidance and sustainability performance, lagged specifications, instrumental variable estimation, and dynamic panel models. Overall, the study provides international evidence that environmental performance represents an important, though partial, pathway through which ESG engagement promotes more responsible corporate tax behavior, offering practical implications for policymakers, investors, and corporate managers seeking to strengthen sustainability, transparency, and fiscal accountability.



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1. Introduction

Corporate tax evasion has become one of the most debated issues in corporate governance (CG) because it directly affects governments' fiscal capacity, market fairness, and public trust in corporations. Although tax planning is generally legal, increasingly aggressive tax avoidance is viewed as inconsistent with responsible corporate behavior

because it weakens the social contract between firms and society and undermines sustainable economic development [1]. Consequently, taxation is increasingly regarded not only as a financial decision but also as an important component of corporate sustainability, accountability, and ethical governance, consistent with the United Nations Sustainable Development Goals (SDGs), particularly SDG 16, which emphasizes transparent institutions and responsible corporate conduct [2,3].

Environmental, social, and governance (ESG) performance has emerged as a key indicator of firms' commitment to sustainable development. ESG practices are expected to strengthen transparency, stakeholder relationships, and long-term firm value while promoting responsible corporate conduct [4–6]. These expectations are grounded in stakeholder theory, which emphasizes accountability to a broad range of stakeholders, and legitimacy theory, which argues that firms seek societal acceptance by aligning their activities with prevailing social norms [7,8]. Accordingly, corporations with robust ESG engagement are anticipated to adopt more responsible tax practices because aggressive tax avoidance may undermine legitimacy, weaken stakeholder trust, and increase reputational and regulatory risks [3,4,9].

Existing evidence generally supports this view. Firms with stronger ESG performance tend to exhibit lower book–tax differences, higher financial reporting quality, and more transparent tax behavior [4–6,10]. For example, El Ghouli [11] shows that mandatory ESG disclosure reduces corporate tax avoidance by improving sustainability performance and stakeholder monitoring [5]. However, empirical findings remain mixed. Some studies report that environmental regulations and sustainability investments increase tax avoidance by imposing additional compliance costs, whereas others find that stronger ESG performance and environmental governance reduce tax avoidance through greater transparency and accountability [12–15]. In addition, some studies document ESG–tax decoupling, whereby firms invest in sustainability initiatives while simultaneously pursuing aggressive tax strategies [16,17]. Collectively, these findings suggest that ESG performance alone cannot fully explain firms' tax behavior and that sustainability initiatives are likely to influence taxation through intermediate organizational mechanisms.

One promising mechanism is carbon performance. Unlike aggregate ESG ratings, carbon performance is an observable and externally verifiable environmental outcome that reflects firms' progress in reducing greenhouse gas emissions [18]. Improving carbon performance typically requires investments in environmental management systems, cleaner production processes, emissions monitoring, and governance practices, thereby strengthening transparency, reducing information asymmetry, and enhancing corporate accountability [5,18,19]. Consequently, carbon performance may represent an important pathway through which ESG engagement influences corporate tax behavior.

This mechanism is further supported by stakeholder and legitimacy theories. Firms demonstrating stronger carbon performance face greater scrutiny from regulators, investors, and society, creating incentives to maintain consistency between environmental commitments and other aspects of corporate conduct, including taxation [7,8]. Consequently, firms with superior carbon performance are expected to avoid aggressive tax strategies that could undermine the credibility of their sustainability commitments. Carbon performance therefore represents not only an environmental outcome but also a governance-related mechanism linking ESG engagement to corporate tax behavior.

In spite of its theoretical relevance, the mediating role of carbon performance remains largely unexplored. Existing research has focused primarily on the direct relationship between ESG performance and corporate tax avoidance, while comparatively little attention has been devoted to explaining the environmental pathways through which sustainability initiatives influence tax behavior. Moreover, most existing evidence is based on

single-country settings, limiting the generalizability of prior findings and overlooking differences in institutional quality, environmental governance, tax enforcement, and ESG disclosure frameworks.

To address these gaps, this study examines whether carbon performance mediates the relationship between ESG performance and corporate tax avoidance using an international panel of 15,840 firm-year observations from 1584 listed firms across 52 countries during the 2015–2023 period. Specifically, the study addresses two research questions:

(RQ1) Does ESG performance reduce corporate tax avoidance?

(RQ2) Does carbon performance mediate the relationship between ESG performance and corporate tax avoidance?

This study makes four contributions. First, it extends the ESG–tax avoidance literature by identifying carbon performance as the environmental pathway through which ESG engagement influences corporate tax behavior, moving beyond the predominantly direct-effect perspective. Second, by focusing on an observable environmental outcome rather than aggregate ESG ratings, it provides new evidence on how sustainability initiatives translate into responsible tax behavior while addressing concerns regarding ESG measurement heterogeneity. Third, using a large international sample covering 52 countries, it provides cross-country evidence that captures institutional diversity and strengthens the external validity of prior research. Finally, it integrates stakeholder and legitimacy theories with recent evidence on environmental governance and corporate taxation to explain how ESG engagement promotes responsible tax behavior through environmental performance.

The empirical outcomes show that robust ESG performance is linked to lower corporate tax avoidance and that carbon performance partially mediates this relationship. These findings indicate that carbon performance represents an important but partial transmission channel through which ESG engagement is associated with more responsible tax behavior. Overall, our study contributes to the growing literature on sustainable corporate governance and offers practical implications for policymakers, regulators, investors, and corporate managers seeking to strengthen ESG credibility, environmental accountability, and fiscal transparency in support of SDGs 12, 13, and 16.

2. Literature Review and Hypothesis Development

2.1. Conceptual Framework

The nexus between ESG performance and corporate tax avoidance can be understood through an integrated theoretical framework combining stakeholder theory, legitimacy theory, and agency theory. While these perspectives collectively suggest that sustainability-oriented firms should adopt more responsible tax practices, they also provide the theoretical basis for explaining how ESG engagement is translated into corporate tax behavior. Specifically, this study argues that carbon performance represents the environmental mechanism through which ESG engagement influences corporate tax avoidance, thereby extending existing research that has predominantly examined the direct ESG–tax avoidance relationship.

Stakeholder theory provides the first foundation for this argument. The theory posits that firms are accountable not only to shareholders but also to governments, regulators, investors, employees, customers, and society. As stakeholder expectations regarding corporate sustainability continue to expand, taxation has increasingly become an important component of responsible corporate behavior because taxes finance public goods, social welfare, and sustainable economic development. Consequently, firms that publicly demonstrate strong ESG engagement are expected to maintain consistency between their sustainability commitments and their financial practices. Aggressive tax avoidance

may therefore create conflicts with stakeholder expectations by undermining transparency, fairness, and corporate accountability.

Recent international evidence reinforces this theoretical argument. El Ghouli et al. (2026) [11] demonstrate that mandatory ESG disclosure regulations reduce corporate tax avoidance through two important transmission channels: enhanced ESG information transparency and improvements in firms' sustainability performance. Their findings indicate that ESG engagement influences corporate tax behavior not only by increasing disclosure but also by strengthening firms' actual sustainability outcomes, which subsequently increase stakeholder monitoring and corporate accountability. Building upon this evidence, the present study argues that carbon performance represents the observable environmental manifestation of these sustainability improvements. Unlike aggregate ESG scores, carbon performance reflects firms' actual environmental achievements and therefore provides a more direct mechanism through which ESG engagement can influence tax behavior.

Legitimacy theory complements this explanation by emphasizing firms' continuous efforts to maintain social acceptance. Organizations seek legitimacy by ensuring that their corporate actions remain consistent with prevailing social values and institutional expectations. As sustainability has become a central element of corporate legitimacy, firms are increasingly expected to demonstrate consistency between environmental commitments and financial conduct. Consequently, firms achieving superior environmental performance may face stronger reputational consequences if they simultaneously engage in aggressive tax avoidance, as such inconsistencies could undermine the credibility of their sustainability initiatives and weaken stakeholder trust.

Agency theory further strengthens this framework by explaining how ESG implementation affects managerial behavior. Managers may pursue aggressive tax planning to maximize short-term financial outcomes when information asymmetry and weak governance reduce effective oversight. However, ESG implementation generally requires stronger governance systems, greater disclosure quality, enhanced internal controls, sustainability committees, and broader stakeholder engagement. These governance mechanisms reduce managerial discretion and improve organizational transparency, thereby limiting opportunities for opportunistic tax planning. Accordingly, the governance improvements associated with ESG implementation provide an additional theoretical explanation for why firms with stronger sustainability engagement may exhibit lower tax avoidance.

Although these theories collectively predict that ESG engagement should discourage aggressive tax avoidance, they do not fully explain how sustainability commitments are translated into firms' financial decisions. This limitation highlights the importance of identifying an intermediate organizational mechanism that operationalizes ESG engagement. The present study proposes that carbon performance fulfills this role because it represents the measurable environmental outcome of firms' sustainability strategies rather than merely their disclosed intentions.

Carbon performance differs fundamentally from aggregate ESG ratings. ESG ratings combine the ESG dimensions into a composite measure that may vary across rating agencies and may partially reflect differences in disclosure practices rather than actual sustainability outcomes. In contrast, carbon performance captures firms' realized success in reducing greenhouse gas emissions and improving environmental efficiency. Achieving superior carbon performance generally requires firms to implement environmental management systems, emissions monitoring, cleaner production technologies, carbon measurement procedures, and transparent environmental reporting. These investments strengthen internal governance, improve information quality, reduce information asymmetry, and enhance accountability throughout the organization. Consequently, carbon performance represents

not only an environmental outcome but also a governance-related organizational capability that may influence financial decision-making.

This interpretation is consistent with recent international evidence. Feng [20] demonstrates that firms engaging in carbon reduction activities exhibit different tax behavior across institutional environments, with the relationship depending on environmental governance, legal systems, judicial independence, media freedom, and carbon-related regulatory frameworks. These findings suggest that carbon-related activities influence tax behavior through governance and institutional mechanisms rather than solely through environmental improvements. Therefore, carbon performance should be viewed as an organizational mechanism linking sustainability implementation with responsible fiscal behavior rather than merely as an environmental outcome.

Nevertheless, alternative theoretical arguments also exist. Environmental regulations, mandatory sustainability disclosure, and climate-related policies often impose substantial compliance costs and financing pressures on firms. Under such circumstances, companies may increase tax avoidance to preserve internal liquidity and offset rising environmental expenditures. Feng [21] shows that China's carbon emissions trading policy increased corporate tax avoidance because environmental regulation reduced corporate cash flows and intensified financing constraints. Similarly, Jiang et al. [22] report that mandatory CSR disclosure increased tax avoidance by raising compliance costs and reducing profitability. At the macro level, ref. [23] further demonstrates that carbon emission reduction may increase tax evasion because environmental investments impose significant financial burdens on firms. Collectively, these studies indicate that environmental pressure itself may increase firms' incentives to engage in aggressive tax planning.

These competing findings reinforce the distinction between environmental pressure and environmental performance. While environmental regulations and sustainability requirements may increase financial pressures, superior carbon performance reflects firms' successful adaptation to those pressures through effective environmental management and stronger governance systems. Firms that achieve higher carbon performance are therefore expected to possess greater organizational capabilities, stronger internal controls, enhanced transparency, and more effective stakeholder engagement, all of which reduce incentives and opportunities for aggressive tax avoidance.

Recent climate-related research further supports the importance of identifying transmission mechanisms between sustainability and corporate taxation. Zhang et al. [24] show that climate risk increases firms' incentives to engage in tax avoidance, whereas strong ESG performance moderates this relationship by encouraging more transparent and socially responsible corporate behavior. Similarly, Persakis and Pavlou [25] demonstrate that climate and environmental governance policy uncertainty affects corporate tax avoidance through financing constraints, highlighting that sustainability-related factors influence tax behavior through intermediate organizational channels rather than solely through direct effects. Extending this emerging literature, the present study proposes that carbon performance constitutes an environmental transmission mechanism through which ESG engagement may promote more responsible corporate tax behavior.

Accordingly, the selection of carbon performance as the mediating variable is theoretically justified for three reasons. First, it represents a tangible and externally verifiable outcome of firms' environmental sustainability strategies, making it less susceptible to symbolic reporting than composite ESG scores. Second, achieving superior carbon performance requires investments in governance systems, environmental monitoring, transparency, and organizational accountability that simultaneously constrain managerial opportunism. Third, firms with superior carbon performance receive greater scrutiny from regulators,

investors, and society, increasing the reputational costs associated with inconsistencies between environmental leadership and aggressive tax avoidance.

Overall, stakeholder theory explains why firms experience increasing external pressure to align sustainability commitments with responsible tax practices, legitimacy theory explains why firms seek consistency between environmental performance and financial conduct to preserve social acceptance, and agency theory explains how stronger governance associated with sustainability implementation constrains managerial opportunism. Carbon performance integrates these theoretical perspectives by representing the observable environmental outcome through which ESG engagement is translated into stronger governance, greater stakeholder monitoring, enhanced organizational legitimacy, and ultimately more responsible corporate tax behavior. This integrated theoretical framework provides the foundation for the hypotheses developed in the following sections.

2.2. Hypothesis Development

Corporate tax avoidance is increasingly recognized as an important aspect of corporate responsibility because firms are expected to align their financial practices with broader sustainability commitments. Stakeholder theory suggests that firms with stronger ESG engagement are subject to greater scrutiny from regulators, investors, governments, and society, whereas legitimacy theory argues that organizations seek to maintain consistency between their sustainability commitments and actual corporate behavior to preserve organizational legitimacy [3,7,8]. Agency theory further suggests that ESG implementation strengthens governance structures, enhances transparency, improves monitoring mechanisms, and reduces managerial discretion, thereby constraining opportunistic tax planning [4–6]. Collectively, these theoretical perspectives imply that firms with superior ESG performance are more likely to adopt responsible tax practices because aggressive tax avoidance may undermine stakeholder trust, damage corporate legitimacy, and increase reputational and regulatory risks.

This theoretical expectation is supported by prior empirical evidence. Earlier studies document that corporations with robust ESG engagement display lower book–tax differences, higher financial reporting quality, lower earnings management, and more transparent tax behavior [4–6,10]. More recently, El Ghoul et al. (2026) [11] demonstrate that mandatory ESG disclosure regulations significantly reduce corporate tax avoidance by improving ESG transparency, strengthening sustainability performance, and increasing stakeholder monitoring, suggesting that sustainability initiatives reinforce corporate accountability and discourage aggressive tax behavior.

Nevertheless, empirical evidence remains heterogeneous. Previous studies document ESG–tax decoupling, whereby firms simultaneously invest in sustainability initiatives while pursuing aggressive tax strategies [14,16]. Likewise, Feng [21] reports that environmental regulation may increase corporate tax avoidance because compliance costs reduce firms' cash flows and intensify financing constraints, while ref. [22] shows that mandatory CSR disclosure may similarly increase tax avoidance by raising compliance costs and reducing profitability. These contrasting findings suggest that ESG engagement may not influence corporate tax avoidance exclusively through a direct effect but rather through specific organizational mechanisms that translate sustainability commitments into corporate financial behavior.

Accordingly, we propose the following hypothesis:

H1. *ESG performance is adversely linked to corporate tax avoidance.*

Building on the above arguments, this study proposes that carbon performance represents the environmental mechanism through which ESG engagement influences corporate

tax avoidance. Unlike aggregate ESG scores, carbon performance reflects firms' realized environmental achievements and demonstrates whether sustainability commitments have been translated into measurable operational outcomes [17,18]. Achieving superior carbon performance requires investments in environmental management systems, emissions monitoring, cleaner technologies, governance processes, and transparent environmental reporting, thereby strengthening organizational accountability, improving information quality, and reducing information asymmetry [10,19]. Existing research further suggests that firms with superior environmental performance provide more credible sustainability disclosures, exhibit stronger governance practices, and are subject to greater stakeholder scrutiny [15].

Recent international evidence further reinforces this theoretical mechanism. El Ghouli et al. (2026) [11] show that improvements in sustainability performance constitute one of the principal channels through which ESG disclosure reduces corporate tax avoidance by enhancing transparency and stakeholder monitoring. Similarly, Feng [20] demonstrates that carbon reduction activities influence firms' tax behavior across different institutional environments, suggesting that realized environmental performance strengthens governance and accountability mechanisms that shape corporate fiscal decisions. Together, these findings indicate that firms successfully translating ESG engagement into superior carbon performance are likely to experience stronger stakeholder monitoring, greater reputational concerns, and enhanced governance, reducing incentives for aggressive tax avoidance.

Accordingly, carbon performance is expected to function as a partial transmission mechanism through which ESG engagement promotes more responsible corporate tax practices.

H2. *Carbon performance partially mediates the relationship between ESG performance and corporate tax avoidance.*

3. Methodology

3.1. Data Sources and Sample Selection

This investigation uses an international panel of publicly listed firms to examine the relationship between ESG performance and corporate tax avoidance and the mediating role of carbon performance. Firm-level ESG scores, carbon performance, governance attributes, financial variables, and tax information were obtained from the "Refinitiv Eikon database", (Refinitiv, London, UK), which affords standardized and internationally comparable data broadly used in sustainability, CG, and accounting research [4,10,15,16].

The sample covers the 2015–2023 period and initially comprises 1584 firms from 52 countries (15,840 firm-year observations). Firms with missing ESG, carbon performance, tax, governance, or financial data were excluded. Financial firms (TRBC Financials) were omitted because of their distinct regulatory environment, and observations with implausible tax-related values were removed following prior studies [11,20].

All continuous variables were winsorized at the 1st and 99th percentiles to reduce the influence of outliers [20], and firms were required to have at least three consecutive annual observations to ensure a balanced panel structure [21]. The final sample spans 10 TRBC economic sectors and reflects substantial institutional and regulatory variation across developed and emerging economies. Details of the sample selection, country composition, industry classification, annual observations, and sample firms are provided in Appendix A.

All empirical models include year, industry, and country fixed effects (FE) to control for sectoral characteristics, macroeconomic shocks, and country-specific institutional and tax environments [3,15].

3.2. Variable Measurement

We use the well-known measures in the ESG, environmental sustainability and corporate tax literature. The dependent variable, corporate tax avoidance, is captured by BTD, which is the difference between financial accounting income and taxable income divided by total assets. The higher the BTD, the greater the difference between financial and taxable income, which is typically interpreted as a signal of higher tax avoidance [4,21,22].

ESG performance is the main independent variable, measured by the composite ESG score obtained from the Refinitiv Eikon database. The ESG score is on a scale of 0–100 and captures firms' environmental, social and governance practices as reported by publicly accessible data [23]. The higher the value, the better the sustainability and responsible business practices [24].

The mediator is carbon performance, which measures firms' environmental efficiency in managing greenhouse gas emissions. Carbon performance is defined as the negative logarithm of carbon intensity (the ratio of total Scope 1–3 greenhouse gas emissions to firm revenues) in accordance with previous environmental accounting research. In particular, carbon performance is:

$$\text{CARBON_PERF} = -\ln(1 + \text{Scope 1–3 emissions} \div \text{revenue})$$

This approach ensures that larger values indicate greater carbon efficiency and better environmental performance while minimizing the impact of extreme emission values [11].

A range of firm characteristics is included as control variables to account for firm characteristics that may affect corporate tax. Firm size (SIZE) and return on assets (ROA) reflect differences in firm size and profitability that may influence firms' motivation and opportunities for tax avoidance [21]. Leverage (LEV) accounts for the impact of debt financing and interest tax shields on tax planning [25]. Asset tangibility (TANG) captures asset characteristics that may impact tax deductions, such as depreciation [26]. Firm age (AGE) reflects the maturity and experience of the organization in governance and compliance [27]. Finally, this study controls for board attributes such as board size (BSIZE) and board gender diversity (BGD) to capture governance structures that could improve monitoring, transparency and ethical financial practices [28]. Table 1 contains full explanations of the variables of interest.

Table 1. Variables and Definitions.

Variable	Symbol	Definition/Measurement
Dependent Variable		
Book–Tax Differences (Tax Avoidance)	BTD	Calculated as accounting income minus taxable income and scaled by total assets.
Independent Variable		
ESG Score	ESG	Composite ESG score (Refinitiv 0–100). Higher values reflect stronger sustainability performance.
Mediator		
Carbon Performance	CARBON_PERF	Negative of carbon intensity: $-\ln(1 + \text{Scope 1–3 emissions} \div \text{revenue})$. Higher values indicate better carbon efficiency.

Table 1. *Cont.*

Variable	Symbol	Definition/Measurement
Control Variables		
Firm Size	SIZE	Natural logarithm of total assets.
Profitability	ROA	Net income ÷ total assets.
Leverage	LEV	Total liabilities ÷ total assets.
Asset Tangibility	TANG	Fixed assets ÷ total assets.
Firm Age	AGE	ln(1 + years since IPO or incorporation).
Board Size	BSIZE	Total number of directors on the board.
Board Gender Diversity	BGD	Percentage of female directors.

3.3. Research Model and Identification Strategy

The empirical framework examines both the direct relationship between ESG performance and corporate tax avoidance and the indirect relationship through carbon performance. This background is grounded in agency, legitimacy, and stakeholder theories, which suggest that ESG-oriented firms face greater stakeholder scrutiny and regulatory pressure, reducing incentives for aggressive tax avoidance [4,6,29]. Carbon performance is therefore proposed as the mechanism through which ESG engagement influences corporate tax behavior.

The analysis follows a three-step mediation framework. First, the baseline model estimates the link between ESG performance and corporate tax avoidance. Second, the mediator model examines whether ESG performance improves carbon performance. Third, the full mediation model tests whether carbon performance transmits the effect of ESG performance on tax avoidance.

Because the multi-country panel data do not permit strict causal inference, the empirical strategy focuses on strengthening internal validity. Endogeneity concerns are mitigated through lagged specifications, industry, year, and country effects, firm-level control variables, and winsorization. The baseline analysis employs random-effects generalized least squares (GLS), with additional instrumental variable (2SLS) and System GMM estimations used to assess robustness.

Further robustness analyses employ alternative measures of tax avoidance and environmental performance, together with heterogeneity tests based on governance quality. This approach is consistent with the ESG and corporate taxation literature, where robust identification relies on complementary econometric techniques and theoretically motivated transmission mechanisms rather than a single estimation method.

3.4. Measurement Equations

This study estimates the direct and indirect pathways through which ESG performance is associated with corporate tax avoidance. Consistent with prior ESG–taxation and mediation studies [4,5,30], three regression equations are specified. All models control for industry, year, and country effects.

Model 1: Baseline ESG → Tax Avoidance

The first model examines whether firms with robust sustainability performance are associated with lower levels of tax avoidance.

$$\text{BTD}_{i,t} = \alpha_0 + \alpha_1 \text{ESG}_{i,t} + \alpha_2 X_{i,t} + \mu_s + \lambda_t + \delta c + \varepsilon_{i,t} \quad (1)$$

where

- $BTD_{i,t}$ represents book–tax differences for firm i in year t , used as a proxy for corporate tax avoidance.
- $ESG_{i,t}$ denotes the ESG performance score for firm i in year t .
- $X_{i,t}$ is a vector of firm-level control variables including firm size, profitability, leverage, asset tangibility, firm age, board size, and board gender diversity.
- μ_s represents industry effects controlling for sector-specific characteristics.
- λ_t captures year effects controlling for macroeconomic and regulatory shocks over time.
- δc represents country effects capturing cross-country institutional and regulatory differences.
- $\varepsilon_{i,t}$ is the error term.

The expected sign of α_1 is negative, indicating that stronger ESG performance is associated with lower levels of corporate tax avoidance.

Model 2: $ESG \rightarrow$ Carbon Performance (Mediator Test)

The second model evaluates whether ESG performance is associated with firms' carbon outcomes, representing the first step in assessing the mediation mechanism.

$$CARBON_PERF_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \beta_2 X_{i,t} + \mu_s + \lambda_t + \delta c + u_{i,t} \quad (2)$$

where:

- $CARBON_PERF_{i,t}$ represents carbon performance for firm “ i ” in year “ t ”, measured as the negative logarithm of carbon intensity:

$$-\ln(1 + \text{Scope 1–3 emissions} \div \text{revenue})$$

Higher values indicate better carbon efficiency.

- $ESG_{i,t}$ denotes ESG performance.
- $X_{i,t}$ represents the vector of firm-level control variables defined above.
- μ_s , λ_t , and δc denote industry, year, and country effects.
- $u_{i,t}$ is the error term.

The expected sign of β_1 is positive, indicating that stronger ESG engagement is associated with improved carbon performance.

Model 3: Mediation Model

The third model examines whether carbon performance transmits part of the relationship between ESG performance and corporate tax avoidance.

$$BTD_{i,t} = \gamma_0 + \gamma_1 ESG_{i,t} + \gamma_2 CARBON_PERF_{i,t} + \gamma_3 X_{i,t} + \mu_s + \lambda_t + \delta c + v_{i,t} \quad (3)$$

where:

$CARBON_PERF_{i,t}$ captures firms' environmental efficiency. A negative coefficient for γ_2 indicates that firms with robust carbon performance unveil lower levels of tax avoidance.

Evidence of mediation exists when the magnitude of the ESG coefficient decreases after including carbon performance in the regression model. In other words, mediation occurs when:

$$|\gamma_1| < |\alpha_1|$$

The magnitude of the indirect (mediated) effect is calculated as:

$$\text{Indirect effect} = \beta_1 \times \gamma_2$$

There is mediation if the indirect effect is statistically significant, and both β_1 and γ_2 are significant. This mediation analysis follows methods commonly employed in sustainability

and corporate governance studies to investigate how ESG performance might be linked to corporate tax policy [30].

To complement the mediation analysis, the statistical significance of the indirect effect is examined with the Sobel test and bootstrapped confidence intervals. These methods offer a direct statistical test of whether the product term ($\beta_1 \times \gamma_2$) is equal to zero, and are preferred in mediation studies as they are not based on the magnitude of the change in coefficients [31]. The bootstrap procedure with 1000 replications is used to calculate standard errors. Mediation is supported if the bootstrap confidence interval for the indirect effect does not contain zero.

These methods enable a direct test for whether the product of coefficients ($\beta_1 \times \gamma_2$) is significantly different from zero and are highly recommended for the analysis of mediation effects as they do not depend only on changes in coefficients [30,31]. Consistent with recent research in sustainability and corporate governance, we use bootstrapping (1000 resamples) to calculate the standard errors of the indirect effect [11,32]. We establish evidence of mediation when the estimated indirect effect is significant and the bootstrap confidence interval does not contain zero.

4. Empirical Analysis

4.1. Summary Statistics

Descriptive statistics are provided in Table 2 for 15,840 firm-year observations from 1584 firms from 52 countries in 2015–2023. The dependent variable (BTD) has a mean of 0.065 and a standard deviation of 0.155, suggesting that there is considerable variability in corporate tax behavior. The positive skewness indicates that while the majority of firms have moderate book–tax differences, some firms have relatively high tax avoidance [21,24].

Table 2. Descriptive Statistics.

Variable	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
BTD	0.065	0.155	−0.420	1.280	1.62	5.88
ESG	62.80	16.90	5.00	94.00	−0.42	−0.18
CARBON_PERF	−2.64	1.32	−8.95	−0.05	−1.21	4.52
SIZE	15.30	2.25	9.00	24.50	0.36	2.66
ROA	0.044	0.065	−0.25	0.32	0.85	3.10
LEV	0.548	0.218	0.030	0.980	0.11	2.46
TANG	0.318	0.198	0.010	0.920	0.55	2.51
AGE	3.34	0.91	0.00	5.30	−0.24	2.34
BSIZE	10.94	2.81	3	24	−0.14	−0.69
BGD	22.10	11.85	0.00	67.00	0.52	−0.62

Notes: All continuous variables are trimmed by winsorizing observations below the 1st percentile and above the 99th percentile to mitigate the influence of extreme observations. Variable explanations are provided in Table 1.

The mean ESG score (62.80) suggests moderate levels of sustainability practices among firms. The mediator, carbon performance, also has significant dispersion, reflecting variations in firms' environmental efficiency [6,11]. The characteristics of firms exhibit typical distributions for international samples. Firm size, leverage and profitability are highly dispersed among firms, and governance measures such as board size and gender diversity also show dispersion. The distributional aspects suggest that the variables are moderately skewed, but do not exhibit high kurtosis, and that the winsorization process adequately controls the effect of outliers. In summary, the variability in the variables is consistent with the use of the data for multiple regression and mediation analysis.

4.2. Correlation and Multicollinearity Analysis

Table 3 shows the correlations between the variables and the variance inflation factors (VIF). The observed correlations are largely consistent with expectations. ESG performance is negatively associated with BTD ($r = -0.18$), implying that firms with greater sustainability engagement may be less likely to engage in tax avoidance. Carbon performance is also negatively correlated with BTD ($r = -0.22$), suggesting that firms with more environmental efficiency might engage in less aggressive tax avoidance. However, ESG performance and carbon performance are positively related ($r = 0.40$), which makes sense given the proximity between sustainability engagement and environmental performance.

Table 3. Correlation Matrix and VIF.

Variable	1	2	3	4	5	6	7	8	9	10	VIF
(1) BTD	1.000										—
(2) ESG	−0.18 ***	1.000									1.9
(3) CARBON_PERF	−0.22 ***	0.40 ***	1.000								1.6
(4) SIZE	0.15 ***	0.30 ***	−0.18 ***	1.000							2.4
(5) ROA	−0.10 ***	0.20 ***	0.06 **	−0.14 ***	1.000						1.4
(6) LEV	0.20 ***	−0.12 ***	−0.05 **	0.30 ***	−0.20 ***	1.000					1.8
(7) TANG	0.07 ***	−0.06 ***	0.00	−0.22 ***	−0.02	0.25 ***	1.000				1.5
(8) AGE	−0.04 **	0.10 ***	−0.12 ***	0.10 ***	0.02	−0.02	0.02	1.000			1.3
(9) BSIZE	−0.03 **	0.13 ***	−0.06 ***	0.38 ***	−0.05 **	0.09 ***	−0.05 **	0.06 ***	1.000		1.9
(10) BGD	−0.07 ***	0.34 ***	−0.11 ***	0.11 ***	0.03 *	−0.07 ***	−0.03 **	0.02	0.05 **	1.000	1.7

Note: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$ (two-tailed).

The correlations between the control variables are relatively low and do not suggest that multicollinearity might be present. This finding is confirmed by the variance inflation factors (VIF), which are all below 2.5 and well below the often used threshold of 10 [33]. This evidence indicates that the explanatory variables represent different aspects of firm characteristics and that multicollinearity is unlikely to have any impact on the validity of the regression estimates reported in the subsequent analysis.

4.3. Baseline Regression Results

A Hausman specification test was conducted to select the appropriate panel estimator. The test yielded a p -value of 0.36, indicating that the null hypothesis of no systematic difference between the fixed-effects and random-effects estimators cannot be rejected. Accordingly, the random-effects estimator is considered consistent and, under the null hypothesis, more efficient than the fixed-effects estimator. Therefore, the baseline models are estimated using random-effects generalized least squares (GLS). Additional robustness tests using 2SLS and System GMM are presented in subsequent sections.

Table 4 reports the baseline relationship between ESG performance and corporate tax avoidance. Across all specifications, ESG performance is negatively and significantly associated with BTD, supporting Hypothesis 1. In Model (1), the ESG coefficient is -0.0016 ($p < 0.01$), indicating that firms with stronger sustainability performance engage in less tax avoidance. This finding is consistent with prior evidence that sustainability-oriented firms adopt more transparent tax practices and face greater stakeholder monitoring [3–5]. In contrast to the ESG–tax decoupling argument [8,14], the results suggest that ESG engagement is associated with more responsible tax behavior rather than with symbolic sustainability practices.

Table 4. Baseline Random-effects GLS panel regression.

Variable	(1)	(2)	(3)	(4) Country Controls
ESG	−0.0016 *** (−4.21)	−0.0015 *** (−4.02)	−0.0010 ** (−2.55)	−0.0009 (−2.41)
CARBON_PERF			−0.0102 *** (−5.31)	−0.0098 * (−5.12)
SIZE	0.0084 ***	0.0079 ***	0.0072 ***	0.0071 ***
ROA	−0.118 ***	−0.115 ***	−0.112 ***	−0.111 ***
LEV	0.052 ***	0.049 ***	0.045 ***	0.044 ***
TANG	0.029 **	0.027 **	0.025 **	0.024 **
AGE	−0.0045 *	−0.0042 *	−0.0038 *	−0.0037 *
BSIZE		−0.0012	−0.0010	−0.0011
BGD		−0.0125 **	−0.0118 **	−0.0114 **
GDP per Capita				−0.0016 (−2.07)
Corruption Control				−0.0034 (−2.46)
Inflation				0.0008 (2.18)
Constant	0.204 ***	0.211 ***	0.220 ***	0.217 ***
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Country/Region FE	Yes	Yes	Yes	Yes
Observations	15,840	15,840	15,840	15,840
Number of Firms	1584	1584	1584	1584
Wald χ^2	132.4 ***	149.7 ***	181.3 ***	194.6 *
Overall R ²	0.13	0.15	0.19	0.21

Notes: z-statistics are reported in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Hausman p -value = 0.36 indicates that random effects is the appropriate estimator for the entire regression framework.

The negative ESG coefficient is consistent with stakeholder, legitimacy, and agency theories, suggesting that stronger ESG practices enhance monitoring, reduce managerial discretion, and encourage responsible corporate behavior. Model (2) adds board governance characteristics, and the ESG coefficient remains negative and significant, indicating that the relationship is not driven solely by board composition.

Model (3) introduces carbon performance as the proposed mediator. Carbon performance is negatively associated with BTD (-0.0102 , $p < 0.01$), while the ESG coefficient declines from -0.0015 to -0.0010 , supporting partial mediation. Carbon performance explains approximately 14% of the total ESG effect on tax avoidance, indicating a statistically significant but modest transmission channel rather than the sole mechanism linking ESG performance to tax avoidance. These findings suggest that firms with stronger environmental management systems also adopt more transparent governance and reporting practices [10,11].

The control variables are generally consistent with expectations. SIZE, LEV, and TANG are positively linked to BTD, whereas profitability (ROA), firm age, and board gender diversity are negatively associated with tax avoidance. The models explain a moderate proportion of the variation in BTD (Overall $R^2 = 0.13$ – 0.21), and the Wald χ^2 statistics confirm the overall significance of the regressions.

Model (4) further includes country-level controls for GDP per capita, corruption, and inflation [33]. ESG performance and carbon performance remain negatively associated with tax avoidance, indicating that the baseline findings are robust to differences in national economic and institutional environments.

4.4. Mediation Analysis: The Role of Carbon Performance

Table 5 presents the mediation analysis examining carbon performance as the mechanism linking ESG performance and corporate tax avoidance.

Table 5. Mediation Analysis: Carbon Performance as Mediator of ESG → Tax Avoidance.

Variables	(1) CARBON_PERF	(2) BTD (Direct Effect)	(3) BTD (Mediator Model)
ESG	0.0215 *** (8.94)	−0.0015 *** (−4.02)	−0.0010 ** (−2.49)
CARBON_PERF			−0.0098 *** (−5.22)
SIZE	−0.061 *** (−7.01)	0.0079 *** (4.59)	0.0072 *** (4.21)
ROA	0.033 ** (2.18)	−0.115 *** (−3.55)	−0.112 *** (−3.47)
LEV	−0.028 ** (−2.42)	0.049 *** (3.84)	0.045 *** (3.59)
TANG	−0.014 (−1.48)	0.027 ** (2.18)	0.025 ** (2.08)
AGE	−0.0081 ** (−2.36)	−0.0042 * (−1.79)	−0.0039 * (−1.72)
BSIZE	0.0041 ** (2.43)	−0.0012 (−1.12)	−0.0010 (−0.96)
BGD	0.0185 *** (4.70)	−0.0125 ** (−2.54)	−0.0118 ** (−2.41)
Constant	−0.832 *** (−6.22)	0.211 *** (6.03)	0.220 *** (6.10)
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Region FE (RE)	Yes	Yes	Yes
Observations	15,840	15,840	15,840
Wald χ^2	204.8 ***	149.7 ***	184.3 ***
Overall R ²	0.21	0.15	0.19

Notes: Robust z-statistics are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Column (1) estimates the effect of ESG on carbon performance (path a). Column (2) reports the direct effect of ESG on tax avoidance. Column (3) includes carbon performance to estimate the mediation effect (paths b and c').

Model (1) estimates the relationship between ESG and carbon performance (path a). ESG is positively and significantly associated with carbon performance ($\beta = 0.0215$, $p < 0.01$), indicating that firms with stronger sustainability engagement achieve better environmental performance. This finding supports prior evidence that ESG initiatives translate into measurable environmental improvements rather than symbolic sustainability practices [17,18].

Model (2) reports the direct relationship between ESG performance and tax avoidance. ESG remains negatively associated with BTD ($\beta = -0.0015$, $p < 0.01$), consistent with the baseline results and previous evidence that sustainability engagement promotes greater transparency and accountability [3].

Model (3) introduces carbon performance as the mediator. Carbon performance is negatively associated with BTD ($\beta = -0.0098$, $p < 0.01$), while the ESG coefficient declines from -0.0015 to -0.0010 but remains statistically significant. This supports partial mediation and Hypothesis 2. Carbon performance explains approximately 14% of the total ESG effect on tax avoidance, indicating a statistically significant but modest transmission mechanism.

These findings are consistent with stakeholder, legitimacy, and agency theories, suggesting that firms committed to environmental sustainability strengthen monitoring, inter-

nal controls, and reporting quality, thereby reducing opportunities for aggressive tax planning [5,10,15]. Firms with stronger environmental management systems are also likely to exhibit greater transparency and accountability in broader corporate governance practices.

Overall, the results indicate that carbon performance represents an important but partial channel through which ESG engagement is associated with lower corporate tax avoidance, extending the literature on the governance implications of environmental performance [1,11,34].

5. Additional Tests and Heterogeneity Analysis

To rule out the possibility that the baseline results are driven by specific measurement choices for tax avoidance or sustainability performance, a series of additional robustness checks are conducted. These tests follow recent ESG–tax studies that employ alternative dependent variables and environmental indicators to confirm the stability of the empirical findings [1,35,36].

5.1. Alternative Measure of Tax Avoidance

To verify that the baseline findings are not sensitive to the choice of tax avoidance proxy, the main model is re-estimated using the Cash Effective Tax Rate (Cash ETR), a widely used cash-based measure of corporate tax avoidance [34–36]:

$$\text{Cash ETR} = \text{Cash taxes paid} \div \text{pre-tax income}$$

Consistent with prior literature, lower Cash ETR values indicate greater tax avoidance. Using an alternative proxy is important because the baseline measure, BTM, although widely applied in the literature, may also capture temporary accounting–tax timing differences or accrual-based earnings management rather than purely aggressive tax planning. Recent research therefore cautions that BTM may reflect both tax planning and financial reporting behavior. For this reason, prior studies recommend validating empirical results using alternative tax avoidance measures in order to mitigate potential proxy-specific bias [36].

Column (1) of Table 6 presents the results using Cash ETR as the dependent variable. ESG remains positive and statistically significant (0.0021, $p < 0.01$), signifying that firms with robust sustainability performance tend to pay higher cash taxes and therefore exhibit lower levels of tax avoidance. Similarly, carbon performance remains positive and statistically significant (0.0087, $p < 0.01$), suggesting that firms with stronger carbon efficiency tend to display more transparent fiscal behavior.

Table 6. Result of Robustness Tests.

Variable	(1) Cash ETR	(2) ENV Model
ESG	0.0021 *** (4.12)	−0.0019 *** (−4.33)
CARBON_PERF	0.0087 *** (5.03)	−0.0098 *** (−5.18)
SIZE	−0.0054 *** (−3.89)	0.0074 *** (4.25)
ROA	0.163 *** (4.27)	−0.111 *** (−3.53)
LEV	−0.032 *** (−3.44)	0.047 *** (3.81)

Table 6. *Cont.*

Variable	(1) Cash ETR	(2) ENV Model
TANG	−0.014 * (−1.78)	0.026 ** (2.15)
AGE	0.0029 (1.21)	−0.0041 * (−1.74)
BSIZE	0.0006 (0.54)	−0.0011 (−1.05)
BGD	0.0071 ** (2.19)	−0.0122 ** (−2.48)
Constant	−0.118 *** (−4.02)	0.216 *** (6.08)
Industry “FE”	Yes	Yes
Year “FE”	Yes	Yes
Country/Region “FE”	Yes	Yes
Obs.	15,840	15,840
Number of firms	1584	1584
Wald χ^2	167.9 ***	179.4 ***
Overall R ²	0.14	0.17

Notes: z-statistics are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Overall, the consistency of the results across specifications indicates that the baseline findings are not dependent on the BTD proxy and remain robust when a cash-based tax metric is employed. This pattern is consistent with recent empirical studies emphasizing the importance of validating ESG–tax relationships across multiple tax avoidance measures [1].

5.2. Alternative Sustainability Metric

As an additional robustness check, the baseline model is re-estimated using ENV, the environmental pillar score, which isolates the environmental dimension of firms’ sustainability practices [4,34]. ENV captures firm-level environmental performance across areas such as emissions management, resource efficiency, and green innovation.

Column (2) of Table 6 reports the results. The coefficient on ENV is negative and highly significant (−0.0019, $p < 0.01$), indicating that firms with robust environmental practices are less likely to engage in tax avoidance.

Importantly, carbon performance remains negative and statistically significant (−0.0098, $p < 0.01$), reinforcing its role as a key pathway through which environmental performance is associated with firms’ tax behavior.

Taken together, these findings indicate that the negative association between sustainability engagement and tax avoidance is not driven solely by the composite ESG measure but also holds when focusing specifically on the environmental dimension. This is consistent with research suggesting that measurable and externally verifiable environmental actions—such as carbon performance—provide stronger signals of corporate accountability than broader CSR narratives.

5.3. Heterogeneity Analysis by Governance Quality

To examine whether the ESG–tax avoidance nexus diverges across firms with different governance environments, a heterogeneity analysis is conducted based on governance quality. Prior studies suggest that the efficiency of ESG practices in constraining opportunistic

managerial behavior often depends on the strength of internal monitoring and oversight mechanisms [16].

Governance quality is measured using the Refinitiv Eikon Governance Pillar Score, which captures key oversight attributes including “board independence”, “board structure”, “gender diversity”, “CEO non-duality”, and “audit committee strength” [5,6]. Firms are divided into high- and low-governance groups based on the sample median, and the baseline random-effects GLS model is estimated separately for each subsample.

The results reported in Table 7 indicate clear heterogeneity across governance environments. In the high-governance subsample, ESG shows a larger and more significant negative association with BTD (-0.00172 , $p < 0.01$), while carbon performance also exhibits a stronger negative coefficient (-0.0123 , $p < 0.01$). In contrast, the low-governance subsample shows weaker coefficients for both ESG and carbon performance. These findings suggest that the association between sustainability engagement and tax behavior is stronger in firms with more robust governance structures, consistent with evidence that effective monitoring enhances the credibility and enforcement of ESG commitments [35].

Table 7. Heterogeneity Analysis: High vs. Low Governance Firms.

Variable	Dependent Variable: BTD	
	(1) Low Governance	(2) High Governance
ESG	-0.00084^{**} (-2.11)	-0.00172^{***} (-4.58)
CARBON_PERF	-0.0065^{***} (-2.49)	-0.0123^{***} (-5.12)
SIZE	0.0068^{***} (3.41)	0.0079^{***} (4.02)
ROA	-0.094^{***} (-3.12)	-0.128^{***} (-3.88)
LEV	0.041^{***} (3.02)	0.053^{***} (4.11)
TANG	0.022^{**} (2.05)	0.031^{***} (2.89)
AGE	-0.0031^{*} (-1.67)	-0.0046^{**} (-2.14)
BSIZE	-0.0010 (-0.96)	-0.0014 (-1.11)
BGD	-0.0102^{**} (-2.21)	-0.0148^{***} (-3.02)
Constant	0.188^{***} (5.44)	0.227^{***} (6.21)
Industry FE	Yes	Yes
Year FE	Yes	Yes
Country/Region FE	Yes	Yes
Observations	7412	8428
Number of firms	745	839
Wald χ^2	119.8 ***	167.3 ***
Overall R ²	0.12	0.19

Notes: z-statistics are reported in parentheses. Robust standard errors are reported. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

5.4. Heterogeneity Analysis by Country Development

To examine whether national institutional environments influence the connection between ESG, carbon performance, and BTD, a heterogeneity analysis is conducted based on countries' level of economic development. Prior studies suggest that stronger institu-

tional quality, regulatory enforcement, investor protection, and environmental governance enhance the effectiveness of ESG initiatives in constraining aggressive tax behavior [15,33].

The classification of countries follows the World Bank's income classification. Firms headquartered in high-income economies are classified as developed countries, whereas those located in upper-middle-, lower-middle-, and low-income economies are classified as emerging countries. Consistent with the empirical strategy described in Section 5.3, separate random-effects GLS regressions are estimated for each subsample.

The results in Table 8 disclose significant heterogeneity across country groups. ESG unveils a stronger negative association with corporate tax avoidance in developed countries (-0.00186 , $p < 0.01$) than in emerging countries (-0.00103 , $p < 0.05$). Similarly, carbon performance has a larger negative effect in developed economies (-0.0135 , $p < 0.01$) than in emerging economies (-0.0078 , $p < 0.01$).

Table 8. Heterogeneity Analysis: Developed vs. Emerging Countries.

Variable	Dependent Variable: BTD	
	(1) Emerging Countries	(2) Developed Countries
ESG	-0.00103^{**} (-2.36)	-0.00186^{***} (-4.91)
CARBON_PERF	-0.0078^{***} (-2.78)	-0.0135^{***} (-5.43)
SIZE	0.0075^{***} (3.26)	0.0072^{***} (3.88)
ROA	-0.101^{***} (-3.18)	-0.135^{***} (-4.02)
LEV	0.045^{***} (3.11)	0.051^{***} (4.06)
TANG	0.025^{**} (2.17)	0.029^{***} (2.95)
AGE	-0.0034^{*} (-1.73)	-0.0048^{**} (-2.27)
BSIZE	-0.0012 (-1.04)	-0.0015 (-1.16)
BGD	-0.0113^{**} (-2.35)	-0.0157^{***} (-3.18)
Constant	0.201^{***} (5.61)	0.236^{***} (6.44)
Industry FE	Yes	Yes
Year FE	Yes	Yes
Country/Region FE	Yes	Yes
Observations	5998	9842
Number of Firms	604	980
Wald χ^2	128.6 ^{***}	175.9 ^{***}
Overall R ²	0.14	0.21

Notes: z-statistics are reported in parentheses. Robust standard errors are reported. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

These findings suggest that stronger institutional environments reinforce the governance and monitoring benefits of ESG initiatives, enabling firms in developed economies to translate sustainability commitments into more responsible tax behavior. Overall, the results support the view that institutional quality strengthens the effectiveness of ESG engagement and carbon performance in reducing corporate tax avoidance.

5.5. Additional Analysis: ESG Sub-Dimensions

To further examine whether the proposed mediation mechanism differs across ESG dimensions, the aggregate ESG score is decomposed into its Environmental (E), Social (S), and Governance (G) pillar scores. The mediation analysis is then re-estimated separately for each ESG dimension using the same empirical specification as the baseline model. This additional analysis identifies which ESG dimension primarily drives carbon performance and, consequently, corporate tax avoidance.

As reported in Table 9, the results indicate clear heterogeneity across the three ESG dimensions. The Environmental pillar unveils the robust association with carbon performance and the largest indirect effect on corporate tax avoidance. Specifically, the Environmental score is positively and significantly associated with carbon performance, while carbon performance remains negatively associated with book–tax differences, indicating a significant partial mediation effect. This finding suggests that firms’ environmental initiatives constitute the primary mechanism through which ESG engagement translates into more responsible tax behavior.

Table 9. Mediation Analysis by ESG Sub-Dimensions.

Variable	(1) Environmental	(2) Social	(3) Governance
ESG Pillar → Carbon Performance	0.0268 *** (9.42)	0.0114 ** (2.31)	0.0076 (1.42)
Carbon Performance → BTD	−0.0107 *** (−5.61)	−0.0089 *** (−4.18)	−0.0074 ** (−2.47)
Indirect Effect	−0.00029 ***	−0.00010 **	−0.00006
Sobel Test	−4.87 ***	−2.15 **	−1.31
Bootstrap 95% Confidence Interval	[−0.00041, −0.00018]	[−0.00019, −0.00002]	[−0.00014, 0.00001]
Mediation Type	Partial	Weak Partial	Not Supported
Firm Controls	Included	Included	Included
Industry FE	Included	Included	Included
Year FE	Included	Included	Included
Country FE	Included	Included	Included
Obs.	15,840	15,840	15,840

Notes: Robust z-statistics are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$. ESG is decomposed into Environmental (E), Social (S), and Governance (G) pillar scores. The indirect effect is calculated using the product-of-coefficients approach with 5000 bootstrap replications. All models include the same firm-level controls and industry, year, and country fixed effects as the baseline regressions.

In contrast, the Social pillar exhibits a weaker but statistically significant indirect effect, implying that social responsibility initiatives may contribute indirectly to responsible tax practices by strengthening stakeholder engagement and organizational accountability. However, the magnitude of this effect is substantially smaller than that of the Environmental pillar.

The Governance pillar does not exhibit a statistically significant indirect effect through carbon performance. This result suggests that governance influences corporate tax behavior mainly through alternative mechanisms, such as enhanced monitoring, board oversight, and internal control systems, rather than through improvements in environmental performance. Overall, these findings demonstrate that the Environmental dimension is the principal driver of the ESG–carbon performance–tax avoidance relationship, thereby providing additional evidence that carbon performance represents the operational implementation of firms’ environmental commitments rather than a generic consequence of overall ESG engagement.

6. Robustness Checks

6.1. Sobel and Bootstrap Mediation Tests

To complement the above analysis of the mediation effect of carbon performance, we also perform supplementary statistical tests of the indirect effect. Although our regression-based mediation analysis (reported in Table 4) suggests partial mediation, formal mediation tests offer additional evidence on the significance of the indirect effect from ESG performance to corporate tax avoidance through carbon performance. In line with the standard approach to mediation analysis [30,37], we conduct Sobel and bootstrap tests.

The results of the Sobel test are presented in Panel A of Table 10. The estimated Sobel z-statistic is -4.50 ($p < 0.001$), suggesting that the product of the coefficients for the ESG $\rightarrow$ CARBON_PERF (path a) and CARBON_PERF $\rightarrow$ BTD (path b) links is significantly different from zero [38]. This finding implies that the indirect effect of ESG performance on tax avoidance via carbon performance is significant.

Table 10. Additional Robustness Tests for the Mediation Effect of Carbon Performance.

Panel A: Sobel Test (ESG → CARBON_PERF → BTD)					
Path	Coeff.	Std. Error	z-value	p-value	
Path <i>a</i> : ESG → CARBON_PERF	0.0215	0.0024	8.94	<0.001	
Path <i>b</i> : CARBON_PERF → BTD	−0.0098	0.0019	−5.22	<0.001	
Indirect effect (<i>a</i> × <i>b</i>)	−0.00021				
Sobel z-value			−4.50	<0.001	
Panel B: Bootstrap Test (5000 Resamples)					
Statistic	Estimate				
Indirect effect (<i>a</i> × <i>b</i>)	−0.00021				
Std. error	0.00005				
95% CI (percentile)	[−0.00031; −0.00012]				
Significance	Indirect effect significant (CI excludes zero)				

Notes: Path a denotes the effect of ESG performance on carbon performance, and Path b denotes the effect of carbon performance on BTD. The Sobel test evaluates the significance of the indirect effect ($a \times b$), while the bootstrap test reports the indirect effect based on 5000 resamples with percentile confidence intervals. Our results support partial mediation.

Panel B reports a non-parametric (5000 resamples) bootstrap test. The indirect effect is -0.00021 , and the 95% percentile confidence interval $[-0.00031; -0.00012]$ does not contain zero. Indirect effects are often not normally distributed, which calls for the use of bootstrap techniques when making inferences about mediation effects [31].

Combining the Sobel and bootstrap tests, it is clear that carbon performance is a statistically significant mediator of the nexus between ESG engagement and corporate tax. These findings complement the regression results in Table 4, which show that carbon performance partly mediates the link between ESG performance and corporate tax avoidance.

6.2. Path Analysis

To better understand the pathway from ESG performance to corporate tax avoidance, a path analysis is performed using the regression coefficients from the models in Tables 4 and 11. The mediation effect is presented in Figure 1, showing the direct and indirect effects of ESG performance on BTD via carbon performance.

The findings show that ESG performance has a positive effect on carbon performance (path a = 0.0215), suggesting that companies with greater sustainability engagement are likely to be more efficient in their carbon emissions. This result is consistent with existing research that finds socially responsible firms are more likely to adopt proper environmental management and emissions reduction strategies [17,18]. In addition, as firms are exposed to climate risks and uncertainties in regulatory, operational and reputational risks, they are likely to engage in better environmental governance and disclosure of sustainable practices.

Table 11. Path Analysis: Direct, Indirect, and Total Effects of ESG on Tax Avoidance.

Path	Relationship	Coefficient	Economic Interpretation
a	ESG → Carbon Performance	0.0215	Higher ESG improves carbon efficiency
b	Carbon Performance → BTD	−0.0098	Better carbon performance reduces tax avoidance
c (total effect)	ESG → BTD	−0.0015	ESG reduces tax avoidance
c' (direct effect)	ESG → BTD (controlling for carbon performance)	−0.0010	ESG still reduces tax avoidance after accounting for mediator
a × b (indirect effect)	ESG → Carbon Performance → BTD	−0.00021	Carbon performance partially transmits the ESG effect
% mediated	(a × b)/c	14%	14% of ESG's effect passes through carbon efficiency

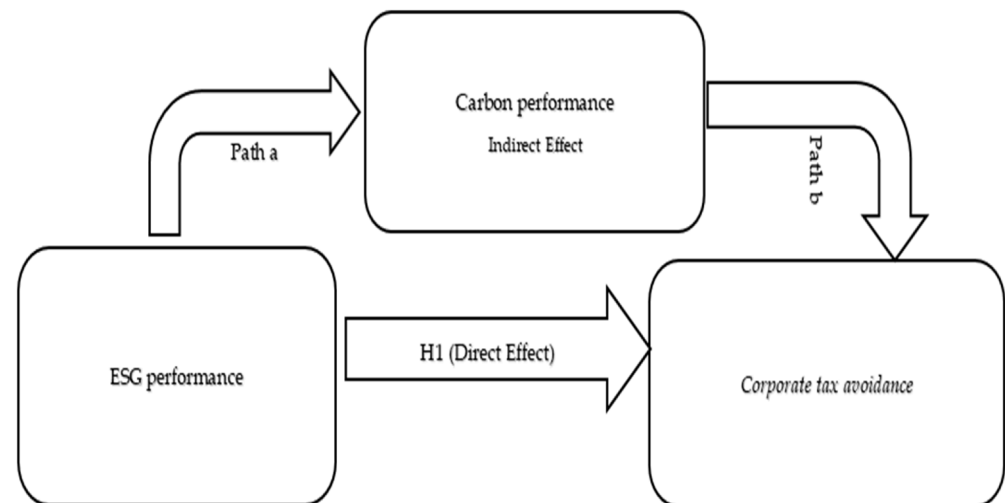


Figure 1. Mediation Mechanism Linking ESG Performance and Corporate Tax Avoidance. Note: Path a represents the effect of ESG performance on carbon performance. Path b represents the effect of carbon performance on tax avoidance. The direct effect (c') captures the remaining influence of ESG performance on tax avoidance after accounting for the mediator.

In turn, carbon performance is negatively related to book–tax differences (path $b = -0.0098$), suggesting that firms with superior environmental efficiency engage in fewer tax avoidance activities. This aligns with research that asserts that higher environmental performance enhances transparency, monitoring and governance, which in turn helps to deter opportunistic financial reporting [5,39–41].

The total effect of ESG performance on tax avoidance is -0.0015 (path c). Controlling for carbon performance, the direct effect drops to -0.0010 (path c'), suggesting that carbon performance accounts for some of the ESG–tax avoidance relationship. The size of the estimated indirect effect ($a \times b = -0.00021$) represents 14% of the total effect, confirming partial mediation. The remaining proportion reflects the direct correlation between ESG engagement and corporate tax behavior, which may be driven by better governance, ethical considerations and investor monitoring associated with firms that prioritize sustainability [4].

Taken together, the path analysis provides further evidence that carbon performance is an environmental governance mechanism through which ESG engagement relates to corporate tax avoidance. These results add to the emerging body of research that explores

the impact of environmental performance and environmental governance pressures on corporate finance and corporate governance [11].

Figure 1 illustrates the mediation mechanism in which carbon performance acts as an intermediary channel linking ESG performance to corporate tax avoidance.

6.3. Endogeneity and Identification Tests

The observed association between ESG performance and corporate tax avoidance (BTD) may suffer from endogeneity stemming from reverse causality, omitted variable bias, and measurement error. Firms with less aggressive tax avoidance may also adopt stronger ESG practices because of governance or reputational considerations. Although the baseline models control for firm-specific features in addition to industry, year, and country fixed effects, these controls may not fully eliminate endogeneity [42,43].

Following prior ESG and corporate taxation studies [5,10], we employ three complementary approaches. First, we estimate a two-step System GMM model to account for dynamic persistence and endogeneity using internal lagged instruments. Second, we apply a 2SLS estimator to isolate the exogenous variation in ESG performance. Third, we re-estimate the models using lagged ESG and carbon performance to establish temporal precedence between sustainability engagement and corporate tax avoidance.

6.3.1. Dynamic Panel Estimation

Firm tax avoidance is likely to exhibit dynamic persistence because corporate tax planning strategies generally evolve gradually rather than changing abruptly from one period to the next. Ignoring this persistence may bias the estimated coefficients due to dynamic panel bias. Furthermore, the link between ESG performance and BTD may be affected by reverse causality as well as omitted firm-specific characteristics. To strengthen causal inference, our study estimates a dynamic panel model using the two-step System Generalized Method of Moments (System GMM) estimator developed by Arellano and Bover [44] and Blundell and Bond [45].

System GMM is well suited for large cross-sectional, short time-series panel datasets because it simultaneously controls for unobserved firm-specific heterogeneity, the endogeneity of explanatory variables, and the dynamic nature of corporate tax avoidance. Following the standard approach in the literature, the lagged dependent variable is included to capture the persistence of tax avoidance behavior. ESG performance and carbon performance are treated as potentially endogenous because firms' sustainability practices and tax planning decisions may be jointly determined. Accordingly, lagged values of these variables are employed as internal instruments under the System GMM framework. The two-step estimator using "Windmeijer-corrected robust standard errors" is used to enhance the efficiency of the estimates while correcting the downward bias in conventional two-step standard errors [46].

Two tests, one for over-identifying restrictions and one for Arellano–Bond serial correlation, are used to assess the dynamic specification's validity. As reported in Table 10, the AR(1) test is significant ($p = 0.001$), which is expected after first differencing, whereas the AR(2) test is insignificant ($p = 0.417$), indicating the absence of second-order serial correlation and supporting the consistency of the moment conditions. The Hansen test is also insignificant ($p = 0.284$), suggesting that the instruments possess joint validity and that the over-identifying restrictions cannot be rejected. Moreover, the number of instruments (42) is substantially lower than the number of firms (1584), indicating that instrument proliferation is unlikely to compromise the reliability of the Hansen test or overfit the endogenous variables.

The System GMM estimates presented in Table 12 further confirm the robustness of the baseline random-effects GLS and instrumental variable results after accounting for dynamic persistence and potential endogeneity. The positive and statistically significant coefficient on the lagged dependent variable {BTD ($t - 1$)} indicates that corporate tax avoidance exhibits persistence over time, supporting the inclusion of a dynamic specification. Consistent with the baseline findings, ESG performance remains negatively associated with corporate tax avoidance in both models. Moreover, carbon performance also exhibits a significant negative association with tax avoidance, indicating that environmentally responsible firms are less likely to engage in aggressive tax planning. The stability of the coefficient signs, magnitudes, and significance levels across the baseline, IV, and System GMM estimations provides strong evidence that the documented connections are not driven by omitted variable bias, reverse causality, or dynamic endogeneity. Overall, these findings reinforce the robustness and reliability of the study's main conclusions.

Table 12. Dynamic Panel Estimation Results.

Variable	(1) BTD	(2) BTD
BTD ($t - 1$)	0.214 *** (5.11)	0.208 *** (4.98)
ESG	−0.0013 ** (−2.41)	−0.0009 ** (−2.12)
CARBON_PERF		−0.0087 *** (−4.03)
SIZE	0.0068 *** (3.62)	0.0064 *** (3.41)
ROA	−0.101 *** (−3.11)	−0.098 *** (−2.94)
LEV	0.043 *** (3.45)	0.039 *** (3.12)
TANG	0.023 ** (2.05)	0.021 ** (1.98)
AGE	−0.0034 * (−1.71)	−0.0031 * (−1.64)
BSIZE	−0.0009 (−0.88)	−0.0008 (−0.79)
BGD	−0.0107 ** (−2.24)	−0.0102 ** (−2.18)
Constant	0.198 *** (4.77)	0.206 *** (4.69)
AR(1) <i>p</i> -value	0.001	0.001
AR(2) <i>p</i> -value	0.417	0.401
Hansen <i>p</i> -value	0.284	0.271
Number of Instruments	42	41
Observations	15,840	15,840
Firms	1584	1584

Notes: Two-step System GMM estimates with Windmeijer-corrected robust standard errors are reported. *t*-statistics are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. AR(1) and AR(2) refer to the Arellano–Bond tests, while Hansen reports the *p*-value of the overidentification test. The instrument count is well below the number of firms, supporting instrument validity.

6.3.2. Two-Stage Least Squares (2SLS) Estimation

We further address the potential endogeneity between ESG performance and corporate tax avoidance using a 2SLS instrumental variable approach. Instrumental variable estimation is widely used in ESG and corporate governance research to mitigate reverse causality, measurement error, and omitted variable bias [21,47].

In line with previous studies, the instrument is the “industry-year average ESG score”, apart from the focal firm. This variable captures common sustainability norms, stakeholder expectations, and competitive pressures that influence firms’ ESG engagement. The instrument satisfies the relevance condition because firms operating within the same industry-year environment are exposed to similar sustainability practices and regulatory pressures. The exclusion restriction is also considered plausible because, after controlling for firm characteristics and industry, year, and country fixed effects, the industry-year ESG environment is not expected to affect a firm’s tax avoidance directly, but only indirectly through its influence on the firm’s own ESG performance [15].

The 2SLS estimation proceeds in two stages. First, firm-level ESG performance is regressed on the industry-year ESG instrument and the control variables. Second, the predicted ESG values are used to estimate BTD. The outcomes are reported in Table 13.

Table 13. Results of Instrumental Variable Estimation.

Variable	(1) ESG (First-Stage)	(2) BTD (Second-Stage)
ESG (Instrumented)		−0.0011 ** (−2.27)
Industry-Year ESG (Instrument)	0.742 *** (18.56)	
CARBON_PERF		−0.0079 *** (−3.64)
SIZE	0.0041 *** (3.12)	0.0065 *** (3.39)
ROA	0.038 ** (2.05)	−0.095 *** (−2.88)
LEV	−0.021 (−1.44)	0.041 *** (3.18)
TANG	−0.006 (−0.73)	0.020 ** (1.99)
AGE	0.002 * (1.71)	−0.0032 * (−1.69)
BSIZE	0.005 ** (2.22)	−0.0008 (−0.82)
BGD	0.014 *** (3.02)	−0.0101 ** (−2.11)
Constant	0.317 *** (5.41)	0.201 *** (4.61)
First-stage F-statistic		112.47
Kleibergen–Paap F-statistic		108.13
Observations		15,840
Firms		1584

Robust standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The first-stage results confirm that the instrument is strongly correlated with firm-level ESG performance. Both the first-stage F-statistic (112.47) and the Kleibergen–Paap F-statistic (108.13) substantially exceed the standard threshold of 10, signifying that the instrument is not weak. The second-stage estimates remain consistent with the baseline random-effects GLS and System GMM results. ESG performance continues to exhibit a negative and statistically significant association with corporate tax avoidance, while carbon performance also remains negatively associated with tax avoidance.

Overall, the 2SLS results provide additional evidence that the adverse link between ESG performance and BTD is robust to potential endogeneity arising from reverse causality and omitted variable bias.

6.3.3. Lagged Variable Specifications

Finally, we run additional specifications with lagged ESG performance and lagged carbon performance to add to our robustness checks. Using lagged regressors helps address concerns that tax outcomes drive sustainability engagement. In our baseline regressions, we consider ESG engagement and corporate tax avoidance at the same time, which could be problematic as firms with less tax avoidance efforts may simultaneously engage in more sustainability investments or disclosure. Thus, the use of lagged explanatory variables establishes a temporal link between sustainability engagement and tax outcomes, which alleviates simultaneity concerns.

The use of lagged models is common in the ESG and corporate governance literature to address potential dynamic interactions between ESG and financial outcomes. Previous research indicates that the effect of ESG practices on corporate policies is typically non-immediate, governed through governance and monitoring processes [11,21,43,48]. In these specifications, ESG performance and carbon performance are lagged by one period, while the control variables and industry, year and country fixed effects are the same as in the baseline models. The results of the estimations are presented in Table 14.

Table 14. Lagged ESG and Carbon Performance Regression Results.

Variable	(1) BTD	(2) BTD
ESG (t − 1)	−0.0012 ** (−2.35)	−0.0010 ** (−2.14)
CARBON_PERF (t − 1)		−0.0081 *** (−3.88)
SIZE	0.0067 *** (3.58)	0.0063 *** (3.32)
ROA	−0.099 *** (−3.04)	−0.094 *** (−2.87)
LEV	0.042 *** (3.33)	0.038 *** (3.05)
TANG	0.022 ** (2.03)	0.020 ** (1.94)
AGE	−0.0033 * (−1.73)	−0.0030 * (−1.66)
BSIZE	−0.0008 (−0.84)	−0.0007 (−0.76)
BGD	−0.0105 ** (−2.19)	−0.0100 ** (−2.09)
Constant	0.204 *** (4.66)	0.210 *** (4.54)

Robust standard errors are shown in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The findings continue to be in line with the baseline and dynamic panel regressions. Specifically, the coefficient on lagged ESG performance is still adverse and important, meaning that corporations with high ESG performance in the past period are still less likely to engage in aggressive tax avoidance. Lagged carbon performance is also negatively and significantly related to tax avoidance. Combined, these lagged models offer further support for the robustness of the ESG–tax avoidance relationship and suggest that it is unlikely to be the result of contemporaneous causal feedback.

7. Discussion

This research offers further evidence that, in a large worldwide sample, improved ESG performance is linked to reduced corporate tax evasion. The findings suggest that firms committed to sustainability are more likely to align their environmental and governance

practices with responsible tax behavior, consistent with stakeholder and legitimacy theories, which argue that firms facing greater stakeholder scrutiny seek consistency across different dimensions of corporate conduct [4,5].

A key contribution of the study is identifying carbon performance as an important, though partial, transmission mechanism linking ESG performance to corporate tax avoidance. While the mediation analysis indicates that carbon performance explains approximately 14% of the total ESG effect, this result suggests that environmental performance represents one meaningful pathway rather than the sole mechanism through which ESG influences tax behavior. Firms achieving stronger carbon performance are likely to implement more effective environmental management, monitoring, and reporting systems, thereby strengthening transparency, accountability, and financial governance [11].

The additional analyses further refine this interpretation. The ESG sub-dimension analysis shows that the Environmental pillar is the primary driver of the mediation effect, whereas the Social pillar plays a weaker role and the Governance pillar does not exhibit a significant indirect effect through carbon performance. This finding suggests that carbon performance reflects firms' environmental commitments rather than the broader ESG construct.

The robustness analyses reinforce these conclusions. The negative ESG–tax avoidance relationship remains consistent across alternative tax avoidance measures, ESG specifications, lagged models, instrumental variable estimation, and System GMM, indicating that the results are unlikely to be driven by model specification or endogeneity. Moreover, the stronger effects observed among firms with higher governance quality suggest that effective governance enhances the ability of sustainability initiatives to influence financial decision-making and tax practices.

Overall, the findings highlight the complementary roles of ESG engagement, environmental performance, and corporate governance in shaping responsible tax behavior. Rather than operating independently, these factors interact to strengthen corporate transparency and accountability. By demonstrating that carbon performance serves as an observable pathway through which ESG engagement is associated with more responsible tax behavior, this study extends the literature on sustainable corporate governance and provides internationally comparable evidence on the environmental foundations of corporate tax transparency.

8. Conclusions and Policy Implications

This study examines the relationship between ESG performance and corporate tax avoidance and investigates whether carbon performance mediates this relationship. Using an international panel of 15,840 firm-year observations from 1584 listed firms across 52 countries during the 2015–2023 period, the findings indicate that companies with better ESG performance engage in less corporate tax avoidance. The findings further indicate that carbon performance partially mediates this relationship, suggesting that observable environmental outcomes represent an important, though not exclusive, transmission mechanism linking sustainability engagement to responsible tax behavior. The results remain robust across alternative measures, lagged specifications, instrumental variable estimation, and System GMM models.

The study also shows that the ESG–tax avoidance relationship is stronger among firms with higher governance quality, indicating that effective governance enhances the implementation of sustainability initiatives and their influence on financial decision-making. Furthermore, the ESG sub-dimension analysis identifies the Environmental pillar as the primary driver of the mediation effect, reinforcing the importance of environmental performance within the broader ESG framework.

This study contributes to the existing literature in three distinct ways. Firstly, it offers international evidence indicating that superior ESG performance is correlated with reduced levels of corporate tax avoidance. Second, it identifies carbon performance as an important but partial transmission mechanism through which ESG engagement influences corporate tax behavior. Third, it demonstrates that governance quality strengthens the relationship between sustainability engagement and responsible tax practices, helping explain the heterogeneous findings reported in previous studies.

The findings also have practical implications. Regulators may consider integrating tax transparency more explicitly into sustainability reporting frameworks, including the Corporate Sustainability Reporting Directive (CSRD), the OECD Base Erosion and Profit Shifting (BEPS) framework, and the International Sustainability Standards Board (ISSB) standards. Greater alignment between sustainability reporting and tax transparency may improve corporate accountability and reporting quality. Investors and corporate managers may also view strong ESG performance and carbon performance as complementary indicators of responsible governance and lower tax-related risk, while firms can strengthen board oversight and governance practices to improve both sustainability performance and fiscal transparency.

This study has several limitations that provide opportunities for future research. First, although firm-level governance characteristics are considered, future studies could incorporate additional country-level institutional variables, including legal quality, tax enforcement, and regulatory effectiveness. Second, future research could examine how climate policies, carbon pricing, and transition risks influence corporate tax behavior. Third, as more detailed emissions data become available, future studies could distinguish the effects of Scope 1, Scope 2, and Scope 3 emissions on corporate tax strategies. Finally, emerging technologies, including digitalization, artificial intelligence, and green innovation, may further influence the relationship between ESG performance and corporate tax avoidance.

Overall, the findings demonstrate that ESG engagement, carbon performance, and corporate governance jointly contribute to more responsible corporate tax behavior. As sustainability reporting and corporate transparency continue to receive greater regulatory attention, understanding the interaction between environmental performance and financial governance will become increasingly important for achieving the broader objectives of SDGs 12, 13, and 16.

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Abbreviations

The following abbreviations are used in this manuscript:

ESG	Environmental, Social, and Governance
BTD	Book–Tax Differences
ETR	Effective Tax Rate
ROA	Return on Assets
LEV	Leverage
SIZE	Firm Size
TANG	Asset Tangibility
AGE	Firm Age
BSIZE	Board Size
BGD	Board Gender Diversity
GLS	Generalized Least Squares
VIF	Variance Inflation Factor
TCFD	Task Force on Climate-related Financial Disclosures
NFRD	Non-Financial Reporting Directive
SDGs	Sustainable Development Goals
GMM	two-step System Generalized Method of Moments
2SLS	two-stage least squares

Appendix A. Distribution of Sample Firms by Country

Table A1. Countries Included in the Sample.

Country	Firms	Country	Firms	Country	Firms
Argentina	5	Ireland	12	South Korea	52
Australia	28	Italy	24	Spain	21
Austria	9	Japan	178	Sweden	24
Belgium	12	Jordan	7	Switzerland	28
Brazil	32	Luxembourg	3	Taiwan	48
Canada	38	Malaysia	15	Thailand	12
Chile	10	Mexico	12	Turkey	12
China	86	Netherlands	22	UAE	5
Czech Republic	5	New Zealand	5	UK	82
Denmark	14	Nigeria	3	US	390
Egypt	4	Norway	9	Vietnam	5
Finland	12	Pakistan	4	Hong Kong	26
France	55	Peru	3	Hungary	4
Germany	48	Philippines	8	Qatar	3
Greece	5	Poland	6	Romania	3
India	58	Portugal	5	Russia	7
Indonesia	15	Saudi Arabia	5	Singapore	14
Total	1584		Countries = 52		

Notes: This table reports the country distribution of the final sample. The sample comprises 1584 listed firms from 52 countries (15,840 firm-year observations) over 2015–2023. Countries are classified according to the locations of the firms' headquarters reported in the Refinitiv Eikon database. UAE, UK, and US denote the United Arab Emirates, United Kingdom, and United States, respectively.

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