EFFECT OF CARBON FOOTPRINT AND SUSTAINABLE FINANCIAL REPORTING ON FIRM VALUE OF LISTED MANUFACTURING FIRMS IN NIGERIA

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Abstract
This study examined the effect of carbon emissions (Scopes 1, 2, and 3) and sustainability financial reporting on the firm value of selected listed firms in Nigeria. It assessed whether emission intensities and recognized sustainability frameworks significantly influence market valuation. Data were collected from nine listed Nigerian firms across key sectors for the period 2012–2023. Variables included emissions per revenue, sustainability reporting, firm size, leverage, and profitability. Descriptive and diagnostic tests were conducted, and model selection was guided by robustness checks. Hypotheses were tested using random effects panel regression with robust standard errors. Findings showed that Scope 2 and Scope 3 emissions had significant positive effects on firm value, with Scope 2 being the strongest predictor. Scope 1 emissions and sustainability reporting were not significant. Firm size and profitability had moderate positive impacts, while leverage showed weak effects. Diagnostic results confirmed model robustness. The findings suggest investors value indirect emissions disclosures (Scopes 2 and 3) more, especially when linked to operational efficiency, whereas inconsistent reporting limits the impact of Scope 1 and sustainability disclosures.

Key words: *Carbon emissions, Firm value, Sustainability reporting, Panel regression, Manufacturing firms, Nigeria*

Introduction

In recent years, global discourse has increasingly emphasized environmental responsibility and corporate sustainability, particularly in the context of climate change and carbon emissions. This trend has triggered a transformation in corporate governance and reporting practices, with a strong emphasis on sustainability and environmental accountability. Nigeria, as one of Africa's largest economies and a resource-intensive nation, faces the dual challenge of fostering economic growth while addressing environmental degradation linked to industrial emissions. Carbon footprint—defined as the total greenhouse gas (GHG) emissions caused directly or indirectly by a firm—has emerged as a critical metric in assessing environmental impact (Elom et al., 2025). These emissions are typically categorized into three scopes: Scope 1 (direct emissions from owned or controlled sources), Scope 2 (indirect

emissions from purchased electricity), and Scope 3 (all other indirect emissions in the value chain). For firms listed on the Nigerian Exchange Group (NGX), managing and reporting these emissions has become increasingly relevant due to evolving global reporting standards and investor expectations. Sustainable financial reporting, especially through frameworks such as the Global Reporting Initiative (GRI) and the International Sustainability Standards Board's IFRS S1 and S2, offers a structured approach for firms to disclose their environmental, social, and governance (ESG) performance. Empirical evidence shows that transparent sustainability disclosure can enhance investor trust and influence market-based performance indicators such as firm value (Okike & Nwachukwu, 2024; Onyekachi, 2025). Moreover, firm value, a proxy for shareholders' wealth maximization, is increasingly being linked to non-financial indicators. In the Nigerian context, where firms face pressure to align with both domestic environmental regulations and international standards, the link between carbon management and firm value is becoming a focus of academic inquiry (Okafor et al., 2024). Studies show that inadequate carbon disclosure can negatively affect firm performance and valuation due to investor perception of environmental risk (Orjinta et al., 2024).

Despite global advancements, carbon disclosure and sustainability reporting remain nascent among many Nigerian firms. Challenges such as inconsistent data reporting, lack of regulatory enforcement, and weak adoption of international standards impede progress (Ele, 2023). However, early evidence from oil and gas firms in Nigeria indicates that robust environmental accounting practices are beginning to show a correlation with improved market value and investor confidence (Chinanu & Folajimi, 2024). Therefore, understanding the relationship between carbon footprint metrics (Scopes 1–3), sustainability reporting practices, and firm value becomes imperative. This study aims to provide empirical insights into how Nigerian firms' environmental transparency contributes to their valuation in capital markets, considering the moderating role of firm-specific characteristics such as size, leverage, and profitability.

Climate change and environmental sustainability are pressing global concerns, and businesses are increasingly held accountable for their carbon footprints and sustainable practices. In Nigeria, carbon emissions and sustainability disclosure have gained recognition, yet corporate reporting frameworks remain weak, underregulated, and inconsistently adopted (Emmanuel & Adenikinju, 2023). Despite global frameworks such as the GRI and IFRS Sustainability Disclosure Standards, most Nigerian firms lack the structural or regulatory incentives to comprehensively measure and report emissions across Scope 1, Scope 2, and Scope 3 categories. Numerous studies suggest that effective carbon disclosure and sustainability reporting can influence firm value by reducing investor uncertainty and enhancing corporate transparency (Ukoh et al., 2024; Orshi & Yusuf, 2024). However, in the Nigerian context, the link between

environmental disclosures and firm value is unclear, especially considering firm-specific factors such as size, leverage, and profitability. While some firms that engage in detailed sustainability reporting show improved market valuations, others report negative or statistically insignificant outcomes (Onoh et al., 2022). Moreover, institutional weaknesses, including lack of enforcement by regulatory agencies and absence of standardized metrics, impede consistent reporting (Aguguom, 2024). Stakeholders—including investors, regulators, and civil society—face information asymmetry due to incomplete or selective disclosure of carbon-related risks (Ukoh et al., 2024).

This asymmetry creates an environment where firm valuation is misaligned with sustainability performance, particularly in sectors such as oil and gas, where environmental risk is materially significant. While global literature continues to validate the value relevance of sustainability disclosures, empirical evidence specific to Nigerian listed firms remains limited and fragmented. The lack of firm-level analysis that distinctly examines Scope 1–3 emissions and how they, alongside sustainability reporting standards, impact firm value creates a significant research gap (Aifuwa, 2020; Erin et al., 2022). Additionally, the moderating effects of firm size, profitability, and leverage are underexplored in Nigerian empirical settings. Thus, this study seeks to fill this critical gap by empirically evaluating the effect of carbon footprint (via emission scopes), and sustainability reporting practices on the firm value of selected listed companies in Nigeria. Addressing this will contribute to policy-making, regulatory strengthening, and enhance corporate decision-making in sustainable development contexts. This study adds to the limited literature on carbon emission disclosures and sustainability reporting in emerging economies by analyzing their effect on firm value in Nigeria. It provides practical insights for managers, investors, and regulators on the financial relevance of environmental disclosures, especially in sectors like oil and gas, manufacturing, and finance. The findings can guide regulatory alignment with global standards and support Nigeria's net-zero commitment. The study focuses on nine listed Nigerian firms from 2019–2023, assessing the impact of Scope 1–3 emissions and sustainability reporting on firm value (measured by Tobin's Q), while controlling for firm size, leverage, and profitability. It emphasizes firms subject to corporate disclosure rules in environmentally significant sectors.

Objectives

The objective of this study is to examine the effect of carbon footprint disclosures—specifically Scope 1, Scope 2, and Scope 3 emissions—and sustainability financial reporting on the firm value of selected listed firms in Nigeria. It aimed to determine the significance of each emission scope and reporting standard in influencing market valuation, while accounting for firm size, leverage, and profitability.

Literature Review

Firm Value

Firm value represents the market's perception of a company's overall worth and is commonly linked to shareholder wealth. In the context of sustainability, firm value reflects not only financial performance but also how well a company manages risks and opportunities related to environmental and social governance. Prior studies suggest that companies demonstrating stronger environmental disclosure often enjoy increased market confidence, improved access to capital, and valuation premiums (Yuan & Bao, 2025; Tang et al., 2025).

Carbon Footprint

Carbon footprint refers to the total greenhouse gas (GHG) emissions released as a result of a company's operations. The widely adopted GHG Protocol categorizes these emissions into:

a. Scope 1: Direct emissions from owned or controlled resources (e.g., company facilities or vehicles)
b. Scope 2: Indirect emissions from the generation of purchased electricity or energy
c. Scope 3: All other indirect emissions across the value chain (e.g., logistics, product use, employee travel)

Conceptually, a high carbon footprint may suggest inefficient or environmentally harmful operations, potentially posing reputational and regulatory risks. Conversely, firms with reduced or transparent emissions are often perceived as forward-thinking, environmentally responsible, and better positioned for long-term success (Easton et al., 2025).

Sustainability Financial Reporting

Sustainability financial reporting refers to the practice of disclosing environmental, social, and governance (ESG) information in corporate reports, often using recognized frameworks such as the Global Reporting Initiative (GRI) or the newly established IFRS S1 and S2 standards. This practice helps firms communicate their long-term value creation strategy, environmental stewardship, and commitment to sustainable business practices. From a conceptual standpoint, sustainability reporting enhances transparency, reduces information asymmetry, and aligns firm operations with the expectations of investors, regulators, and society (Easton et al., 2025; Singh et al., 2024).

Interaction of Concepts

Theoretically, firms that proactively disclose their carbon emissions and adopt sustainability reporting frameworks are likely to build trust with stakeholders, reduce environmental risk exposure, and enhance market reputation. This, in turn, may contribute positively to firm value. Studies have increasingly shown that the integration of non-financial metrics into business strategy is viewed favorably by the capital market (de Beaufort, 2024). Furthermore, the relationship between environmental disclosures and firm value may be influenced by firm-specific characteristics (explored in later sections), but at the core, these three constructs—carbon footprint, sustainability reporting, and firm value—represent a triangle of accountability, transparency, and performance.

Theoretical Review

This study draws on four well-established theories to explain the conceptual basis of carbon emission disclosures, sustainability financial reporting, and their influence on firm value. These theories are: Agency Theory, Legitimacy Theory, Stakeholder Theory, and Signaling Theory. Together, they offer insights into why firms choose to disclose environmental information and how such practices can influence market-based performance outcomes.

Agency theory focuses on the relationship between principals (shareholders) and agents (managers). In this context, environmental disclosures—including carbon emission reporting and sustainability practices—serve to reduce information asymmetry and align managerial decisions with shareholder interests. Transparent ESG disclosures can act as a monitoring mechanism, lowering agency costs and increasing investor trust. When managers disclose credible sustainability data, they signal accountability, which can enhance firm value (Meqbel et al., 2025).

Legitimacy theory posits that firms operate within a "social contract" and must align their practices with the values and expectations of society to maintain legitimacy. In economies where environmental degradation is a concern—such as Nigeria—firms that fail to address their carbon impact may face reputational damage and loss of stakeholder support. Sustainability reporting and emission disclosures help firms demonstrate environmental responsibility, preserving or restoring legitimacy in the eyes of stakeholders (Singh et al., 2024).

Stakeholder theory broadens the accountability of firms beyond shareholders to include all parties affected by corporate actions—such as customers, regulators, employees, and local communities. From this perspective, disclosing carbon footprint and sustainability performance reflects a firm's effort to fulfill its obligations to a diverse set of

stakeholders. Firms that are responsive to stakeholder concerns are more likely to enjoy long-term support, access to resources, and market credibility, which can ultimately drive firm value (de Beaufort, 2024).

Signaling theory explains how firms communicate private information to external stakeholders through observable signals. Voluntary carbon disclosures and sustainability reporting serve as signals of superior management quality, environmental stewardship, and long-term strategic orientation. By adopting globally recognized reporting standards (e.g., GRI, IFRS S1/S2), firms send positive signals to investors about their risk management practices and ethical standards. Such signals can attract investment and positively affect market valuation (Easton et al., 2025).

These theories collectively justify the conceptual foundation of the study, suggesting that carbon footprint transparency and sustainability reporting are not merely compliance tools but strategic resources that influence stakeholder perceptions and firm valuation. They form the theoretical basis for the research model tested in subsequent sections.

Empirical Review

This section reviews empirical studies that examine the relationship between carbon emissions disclosures, sustainability financial reporting, and firm value. The discussion is structured around the four core variables of this study: Carbon Emission Scope 1, Scope 2, Scope 3, Sustainability Financial Reporting, and Firm Value. Each subsection aligns with one of the study's hypotheses.

Carbon Emission Scope 1 and Firm Value

Carbon Emission Scope 1 refers to direct emissions from a firm's operations—such as combustion sources controlled by the company. These emissions are typically more measurable and are often the first step toward environmental accountability.

Empirical evidence suggests a positive link between Scope 1 emission disclosures and firm value. Okike and Nwachukwu (2024), in a study of listed oil and gas firms in Nigeria, found that transparent disclosure of Scope 1 emissions significantly improved market value added, especially when embedded within a structured sustainability framework. Their findings indicate that such disclosures reduce uncertainty and improve investor confidence.

Similarly, Meqbel et al. (2025) examined audit committee roles across African and European firms and found that robust governance, combined with clear Scope 1 reporting, was positively associated with firm valuation.

However, Onoh et al. (2022) observed that in Nigeria, many firms either provide vague Scope 1 data or fail to report it altogether, weakening its influence on market performance. This suggests that disclosure quality and credibility are crucial in determining value relevance.

Based on the conceptual and theoretical perspectives reviewed, the following hypothesis was formulated to examine the role of direct (Scope 1) carbon emissions disclosure in explaining firm value:

H_{01}: Scope 1 carbon emission disclosure has no significant effect on the firm value of listed firms in Nigeria.

Carbon Emission Scope 2 and Firm Value

Scope 2 emissions involve indirect emissions from the consumption of purchased electricity, heat, or cooling. While less visible than Scope 1, Scope 2 emissions reflect energy efficiency and operational sustainability.

Aguguom (2024) found that manufacturing firms in Nigeria that voluntarily disclosed Scope 2 emissions were viewed more favorably by investors, especially when disclosures were linked to energy-saving initiatives. His findings showed a growing awareness of energy-related disclosures, with moderate but positive influence on firm value.

On a broader scale, Yuan and Bao (2025) analyzed firms across emerging markets and reported that investors increasingly respond to Scope 2 emissions when expressed relative to revenue. Their results showed that emission intensity (e.g., Scope 2 per unit revenue) was a stronger predictor of firm value than total emissions, especially in energy-intensive industries.

These studies collectively suggest that while Scope 2 disclosures may not have as strong an impact as Scope 1, their influence is growing as global carbon accounting practices evolve. The second hypothesis was developed to assess the influence of indirect (Scope 2) emissions on firm value:

H_{02}: Scope 2 carbon emission disclosure has no significant effect on the firm value of listed firms in Nigeria.

Carbon Emission Scope 3 and Firm Value

Scope 3 covers indirect emissions across the value chain, including procurement, logistics, waste, and end-user product use. It is the broadest and most complex emission category, yet increasingly relevant in ESG discourse.

Emovon and Ogbonmwan (2025) examined oil and gas companies in Nigeria and found that firms disclosing Scope 3 emissions—especially when framed within SDG-based sustainability goals—experienced positive shifts in investor perception and valuation. Scope 3 transparency was viewed as a signal of long-term risk management.

Globally, Tang et al. (2025) showed that comprehensive GHG reporting, particularly with Scope 3 inclusion, led to greater peer innovation and improved stock performance. However, they emphasized that structured disclosure frameworks (e.g., GRI, IFRS S2) were essential for investors to interpret Scope 3 data meaningfully.

In contrast, Onoh et al. (2022) noted that Scope 3 reporting among Nigerian firms was rare and often lacked standardization. Consequently, its influence on firm value was inconsistent unless disclosures were independently verified or internationally benchmarked.

Considering the increasing attention to value chain emissions and broader environmental accountability, the third hypothesis explores the effect of Scope 3 carbon emission disclosure on firm value:

H_{03}: Scope 3 carbon emission disclosure has no significant effect on the firm value of listed firms in Nigeria.

Sustainability Financial Reporting and Firm Value

Sustainability Financial Reporting refers to the integration of ESG and SDG-related metrics into corporate reports, often in alignment with international frameworks such as the GRI Standards, IFRS S1/S2, or Integrated Reporting (IR).

Easton et al. (2025) emphasized that modern financial reporting must incorporate sustainability dimensions to remain relevant to investors. Their study found that firms with structured sustainability disclosures experienced enhanced investor confidence and improved market capitalization.

In the Nigerian context, Emovon and Ogbonmwan (2025) demonstrated that firms reporting on SDG-aligned sustainability metrics performed better financially and had improved access to capital. Their findings suggest that beyond regulatory compliance, sustainability reporting can be a strategic value driver.

However, Aguguom (2024) highlighted a gap in Nigeria's reporting landscape, where many firms disclose sustainability-related data without consistency or audit verification, thereby limiting the credibility and value relevance of such reports.

To evaluate the strategic importance of structured sustainability disclosures, the fourth hypothesis examines whether the adoption of recognized sustainability reporting

standards influences firm value:

H_{04}: Sustainability financial reporting has no significant effect on the firm value of listed firms in Nigeria.

Synthesis of Empirical Evidence

Across the reviewed literature, there is growing empirical support for the positive impact of carbon emissions disclosure and sustainability reporting on firm value. However, the magnitude and significance of this impact depend on factors such as industry type, quality of disclosure, governance mechanisms, and adherence to global reporting standards.

Methodology

This study used a quantitative, ex-post facto research design to examine how carbon emission disclosures (Scope 1–3) and sustainability reporting affect firm value, based on historical data. It also adopted a descriptive and correlational approach to explore patterns and relationships among variables. Panel data from 2012 to 2023 enabled analysis across firms and time, enhancing result reliability and hypothesis testing within the Nigerian context. The study focused on firms listed on the Nigerian Exchange Group (NGX), which includes over 150 companies across major sectors. Using purposive sampling, nine firms were selected based on their consistent disclosure of Scope 1–3 carbon emissions and sustainability reporting between 2019 and 2023. These firms represent environmentally significant sectors and were chosen to ensure data availability and relevance to the study's objectives.

Table 1: Selected Sample of Firms

S/N	Company Name	Sector
1	BUA Cement Plc	Industrial Goods
2	Chemicals & Allied Products	Industrial Goods
3	Dangote Cement Plc	Industrial Goods
4	Dangote Sugar Plc	Consumer Goods
5	MTN Nigeria Communication Plc	ICT
6	Nascon Allied Plc	Consumer Goods
7	Seplat Petroleum Dev. Co. Plc	Oil and Gas
8	Stanbic IBTC Holding Plc	Financial Services
9	Sterling Bank Plc	Financial Services

Source: Researchers' Compilation

These firms were deliberately selected to reflect diverse industries, allowing the study to analyze the variations in carbon disclosure practices across high-emission (e.g., oil

and gas, cement) and low-emission (e.g., financial services) sectors. Their participation in sustainability reporting initiatives and public availability of environmental and financial data make them suitable for inclusion in the analysis. This sampling strategy enhances the validity and reliability of the study, ensuring that conclusions drawn are grounded in empirical evidence and aligned with international sustainability disclosure standards. This study used secondary data from the annual and sustainability reports of nine listed Nigerian firms spanning 2012–2023. These sources provided information on carbon emissions (Scopes 1–3), sustainability reporting, and firm value, alongside control variables such as firm size, leverage, and profitability. Disclosures aligned with standards like GRI, IFRS S1/S2, or the SDGs were extracted from integrated reports and company websites, with data cross-validated using NGX platforms and CDP submissions where applicable. This ensured consistency and reliability for robust statistical analysis.

Model Specification

The econometric model for this study is designed to examine the effect of carbon emission disclosures (Scopes 1, 2, and 3) and sustainability financial reporting on the firm value of selected listed firms in Nigeria. The model also controls for firm-specific characteristics—namely, firm size, leverage, and profitability—to isolate the impact of the main independent variables. The dependent variable, firm value, was proxied by market capitalization, calculated as the product of a company's share price and the number of outstanding shares. The key explanatory variables include Scope 1, Scope 2, and Scope 3 carbon emissions, each measured relative to company revenue to account for firm scale. Sustainability reporting is treated as a binary variable, coded as 1 if a firm discloses sustainability information in line with recognized standards (e.g., SDGs, GRI, IFRS S1/S2), and 0 otherwise.

The econometric model is specified as follows:

$TOBINQ_{it} = \beta_0 + \beta_1 S1_{it} + \beta_2 S2_{it} + \beta_3 S3_{it} + \beta_4 SRS_{it} + \beta_5 FS_{it} + \beta_6 LEV_{it} + \beta_7 ROA_{it} + \mu_i + \tau_t + \varepsilon_{it}$…..... Eqn 1.

Where:

TOBINQ = Firm value (Tobin Q)

S1 = Scope 1 emissions per unit of revenue (Emission_Scope1 / Revenue)

S2 = Scope 2 emissions per unit of revenue (Emission_Scope2 / Revenue)

S3 = Scope 3 emissions per unit of revenue (Emission_Scope3 / Revenue)

SRS = Sustainability reporting dummy (1 = reporting aligned with SDGs/GRI/IFRS, 0 = otherwise)

FS = Firm size (natural log of total assets)

LEV = Leverage (total debt / total equity)

ROA = Profitability (return on assets or ROA)

ε = Error term
i = Firm index
t = Time index (year)

This is a panel data regression model that accounts for both cross-sectional and time-series variations among firms over the 12-year period (2012–2023). Depending on the result of the Hausman specification test, either a fixed effects or random effects model will be employed to ensure robustness and consistency of parameter estimates.

Table 2: Measurement of Variables with Supporting Literature

Variable	Symbol	Description	Measurement/Formula	Supporting Literature
Firm Value	TOBIN Q	Proxy for firm performance and market valuation	Market Value of Equity / Book Value of Assets	Aigienohuwa & Erah (2025); Emovon & Ogbonmwan (2025)
Scope 1 Emissions Intensity	S1	Direct GHG emissions from owned/controlled sources per unit revenue	Emission_Scope1 / Revenue	Okike & Nwachukwu (2024); Meqbel et al. (2025)
Scope 2 Emissions Intensity	S2	Indirect emissions from electricity, steam, or heat per unit revenue	Emission_Scope2 / Revenue	Aguguom (2024); Yuan & Bao (2025)
Scope 3 Emissions Intensity	S3	Other indirect emissions (value chain, logistics, use) per unit revenue	Emission_Scope3 / Revenue	Tang et al. (2025); Emovon & Ogbonmwan (2025)

Sustainability Reporting	SRS	Indicator of alignment with SDG/GRI/IFRS sustainability reporting standards	Dummy: 1 = aligned, 0 = not aligned	Easton et al. (2025); Aguguom (2024)
Firm Size	FS	Firm's scale and operational capacity	Natural Log of Total Assets	Aigienohuwa & Iyamu (2025); Yuan & Bao (2025)
Leverage	LEV	Capital structure and financial risk	Total Debt / Total Equity	Aigienohuwa & Irowa-Omeregie (2025);; Onoh et al. (2022)
Profitability	ROA	Financial efficiency in asset utilization	Net Income / Total Assets	Aguguom (2024); Meqbel et al. (2025)

Source: Researchers' Compilation

Diagnostic Tests and Data Estimation Techniques

This study conducted key diagnostic tests to validate the panel regression models. Normality was assessed using Shapiro-Wilk and Skewness/Kurtosis tests, revealing non-normality and justifying the use of robust methods. Multicollinearity was checked via VIF, with no serious issues detected. Heteroskedasticity was addressed using the Breusch-Pagan and Modified Wald tests, leading to the use of robust standard errors. The Ramsey RESET test showed no specification errors, and the xtdpdserial test indicated no autocorrelation.

Model selection began with the Breusch-Pagan LM test, which supported random effects over pooled OLS. Although the Hausman test was inconclusive, further checks supported the use of a robust panel random effects model. Robust regression and clustered standard errors were also used to confirm the stability of results.

Data Analysis and Results

Descriptive Statistics

This section presents the summary statistics of the variables used in the study, providing an overview of their distribution, central tendencies, and dispersion. The analysis covers the dependent variable (firm value, proxied by Tobin's Q), independent variables (Scope 1–3 emissions and sustainability reporting), and control variables (firm size, leverage, and profitability).

Table 3: Descriptive Statistics of Study Variables (2019–2023)

Variable	Mean	Median (p50)	Max	Min	Standard Deviation	N
TOBINQ	1.40	0.82	3.80	0.63	0.89	29
S1	0.0019	0.0002	0.014	0.000044	0.0035	29
S2	0.00031	0.000072	0.0024	0.00000019	0.00058	27
S3	0.00044	0.00011	0.0025	0.00000017	0.00073	24
SRS	0.76	1.00	1.00	0.00	0.44	29
FS	21.00	21.00	22.00	16.00	1.60	29
LEV	73.00	77.00	91.00	45.00	17.00	29
ROA	6.30	2.90	16.00	-12.00	6.90	29

Keys: TOBINQ – Tobin's Q, a proxy for firm value; S1 – Scope 1 Emissions Intensity; S2 – Scope 2 Emissions Intensity; S3 – Scope 3 Emissions Intensity; SRS – Sustainability Reporting Standard; FS – Firm Size; LEV – Leverage; and ROA – Return on Assets.

Source: Researchers' Computation (2025) using Stata 17

The average Tobin's Q (1.40) reveals moderate firm value, with a wide dispersion (SD = 0.89), suggesting varying market perceptions. Scope 1 emissions per revenue had the highest mean (0.0019), reflecting the prominence of direct emissions, while Scope 2 and 3 showed lower but more variable values. Sustainability reporting (mean = 0.76) indicates that most firms align with recognized standards. Control variables show moderate firm size (mean log assets = 21.00), high leverage (mean = 73%), and diverse profitability (ROA range: -12% to 16%). These figures reflect heterogeneity in firm operations, structure, and disclosure practices.

Diagnostic Tests

Before conducting the regression analysis, key diagnostic tests—including normality, multicollinearity, heteroskedasticity, autocorrelation, and model specification—were performed to ensure the validity and robustness of the econometric model.

Normality Test

To assess whether the variables meet the assumption of normal distribution, two complementary tests were conducted: the Skewness/Kurtosis test for normality (Table 2a) and the Shapiro–Wilk W test (Table 2b).

Table 4: Skewness/Kurtosis Tests for Normality

Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	Adj Chi²(2)	Prob > Chi²
TOBINQ	29	0.0091	0.3377	6.91	0.0317
S1	29	0.0000	0.0037	18.27	0.0001
S2	27	0.0000	0.0005	22.16	0.0000
S3	24	0.0002	0.0140	14.55	0.0007
SRS	29	0.0066	0.7174	6.75	0.0342
FS	29	0.0003	0.0140	14.32	0.0008
LEV	29	0.5410	0.0000	18.94	0.0001
ROA	29	0.3149	0.8602	1.11	0.5737

Table 5: Shapiro–Wilk Test for Normality

Variable	Obs	W Statistic	V	Z	Prob > Z
TOBINQ	29	0.79210	6.443	3.844	0.00006
S1	29	0.60129	12.357	5.188	0.00000
S2	27	0.58542	12.188	5.136	0.00000
S3	24	0.62225	10.189	4.733	0.00000
SRS	29	0.89262	3.328	2.481	0.00655
FS	29	0.77738	6.900	3.985	0.00003
LEV	29	0.82505	5.422	3.488	0.00024
ROA	29	0.90172	3.046	2.298	0.01078

Keys: TOBINQ – Tobin's Q, a proxy for firm value; S1 – Scope 1 Emissions Intensity; S2 – Scope 2 Emissions Intensity; S3 – Scope 3 Emissions Intensity; SRS – Sustainability Reporting Standard; FS – Firm Size; LEV – Leverage; and ROA – Return on Assets.

Source: Researchers' Computation (2025) using Stata 17

The results from Table 4 show that for most variables—particularly Scope 1 (S1), Scope 2 (S2), Scope 3 (S3), Firm Size (FS), Leverage (LEV), and Sustainability Reporting Standard (SRS)—the adjusted Chi-squared statistics are significant at the 1% level, indicating a rejection of the null hypothesis of joint normality. Only Return on Assets (ROA) displayed no significant deviation from normality (Prob > Chi² = 0.5737).

The Shapiro–Wilk test results in Table 5 further confirm these findings. The W statistics for most variables fall well below 0.90, with highly significant p-values (Prob > Z < 0.01), confirming that the variables deviate from normal distribution. For instance, Scope 2 and Scope 3 exhibit extreme deviations (W = 0.585 and 0.622 respectively, p < 0.0001). Even TOBINQ (Firm Value) and SRS display non-normality with p-values

less than 0.01.

These results suggest that the dataset does not satisfy the assumption of normality for most variables. Consequently, the study employs robust regression techniques and heteroskedasticity-consistent standard errors in subsequent estimations to correct for potential violations of classical linear regression assumptions.

Multicollinearity Test

Multicollinearity refers to the presence of high intercorrelations among independent variables in a regression model, which can distort coefficient estimates and weaken statistical inference. To assess this, the study employed the Variance Inflation Factor (VIF) test. The results are presented in Table 6.

Table 6: Multicollinearity Test – Variance Inflation Factor (VIF)

Variable	VIF	1/VIF
S3 (Scope 3 Emissions)	4.18	0.2392
S2 (Scope 2 Emissions)	3.69	0.2712
ROA (Profitability)	3.36	0.2973
LEV (Leverage)	2.67	0.3743
FS (Firm Size)	2.67	0.3745
S1 (Scope 1 Emissions)	2.47	0.4048
SRS (Sustainability Reporting)	1.56	0.6406
Mean VIF	**2.94**	

Keys: TOBINQ – Tobin's Q, a proxy for firm value; S1 – Scope 1 Emissions Intensity; S2 – Scope 2 Emissions Intensity; S3 – Scope 3 Emissions Intensity; SRS – Sustainability Reporting Standard; FS – Firm Size; LEV – Leverage; and ROA – Return on Assets.

Source: Researchers' Computation (2025) using Stata 17

As shown in the table, all VIF values fall below the commonly accepted threshold of 10, which indicates that multicollinearity is not a major concern in the dataset. The highest VIF value is recorded for Scope 3 emissions (S3) at 4.18, followed by Scope 2 emissions (S2) at 3.69, and return on assets (ROA) at 3.36. These values remain well within the acceptable range, suggesting no severe linear dependency among the explanatory variables. The mean VIF across all predictors is 2.94, which is considerably below the critical cutoff. Therefore, it can be concluded that the independent variables in the model do not exhibit problematic multicollinearity, and the regression estimates can be considered stable and reliable in this regard.

Heteroskedasticity Test

To test for the presence of heteroskedasticity in the regression model, the study applied the Breusch–Pagan / Cook–Weisberg test, using the fitted values of the dependent variable (Tobin's Q) as the explanatory variable. This test evaluates whether the variance of the residuals is constant across all levels of the independent variables.

Table 7: Breusch–Pagan / Cook–Weisberg Test for Heteroskedasticity

Test	Value
Null Hypothesis	Constant variance (homoskedasticity)
Dependent Variable	TOBINQ (Firm Value)
χ^2 (1 df)	8.20
Prob > χ^2	**0.0042**

As shown in the result, the chi-square statistic is 8.20, with a p-value of 0.0042. Since this p-value is less than the 0.05 significance level, we reject the null hypothesis of constant variance. This indicates the presence of heteroskedasticity, meaning that the error terms do not have equal variance across observations.

Given this violation of one of the classical linear regression assumptions, the study proceeds by adopting robust standard errors and robust estimation techniques in the regression analysis to correct for the presence of heteroskedasticity and ensure consistent and efficient parameter estimates.

Model Specification Test

To evaluate the adequacy of the model's functional form and detect any potential omitted variable bias, the study employed the Ramsey Regression Equation Specification Error Test (RESET). This test assesses whether higher-order powers of the fitted values significantly improve the explanatory power of the model, which would indicate misspecification due to omitted variables or incorrect functional form.

Table 8: Ramsey RESET Test for Model Specification

Test	Value
Null Hypothesis	Model has no omitted variables
Test Statistic (F-value)	0.36
Degrees of Freedom (df)	(3, 13)
Prob > F	**0.7826**

The test result, as shown in Table 8, reveals an F-statistic of 0.36 with a p-value of 0.7826. Since the p-value is well above the 0.05 significance level, we fail to reject the null hypothesis that the model is correctly specified. This implies that the model does not suffer from omitted variable bias or incorrect functional form, and the regression specification adopted is appropriate for explaining the relationship between carbon emissions, sustainability reporting, and firm value. This finding further supports the

robustness of the estimated results in the subsequent sections.

Test for Random Effects

To determine the appropriateness of using a random effects panel model as opposed to a pooled ordinary least squares (OLS) model, the study employed the Breusch and Pagan Lagrangian Multiplier (LM) test for random effects. This test evaluates whether there are significant panel-level (firm-level) effects that justify the use of a random effects model over the more restrictive pooled OLS approach

Table 9: Breusch and Pagan LM Test for Random Effects

Component	Variance (Var)	Standard Deviation (SD)
TOBINQ (Total)	0.8684	0.9319
e (idiosyncratic error)	0.0849	0.2913
u (random effects)	0.0000	0.0000
Test	Value	
Null Hypothesis	Var(u) = 0 (no random effects)	
Test Statistic (chibar²(01))	0.00	
Prob > chibar²	**1.0000**	

As shown in Table 9, the variance component for the random effect term (u) is estimated to be zero, and the test statistic (chibar²(01)) is 0.00, with a corresponding p-value of 1.0000. This result indicates that the null hypothesis of no panel-level effects (i.e., Var(u) = 0) cannot be rejected. In other words, there is no statistical justification for the use of a random effects model, as the variation across entities (firms) is not significantly different from zero. Based on this outcome, the study concludes that a pooled OLS model is more appropriate for estimating the relationship between carbon emissions, sustainability reporting, and firm value for the sample under consideration.

Autocorrelation Test

To assess the presence of serial correlation in the panel data structure, the study employed a series of Portmanteau-type autocorrelation tests using the xtdpdserial command in STATA. These tests are important for validating one of the key assumptions of classical regression—that the residuals are not serially correlated across time periods. Autocorrelation, if present, can bias standard errors and lead to inefficient parameter estimates.

Table 10: Tests for Autocorrelation in Panel Data

Test Type	Chi² (df)		Prob > Chi²	Null Hypothesis
Portmanteau test	$\chi^2(3)$ 3.0000	=	0.3916	No autocorrelation of any order
Collapsed test in seasonal differences	$\chi^2(2)$ 2.0124	=	0.3656	No autocorrelation of any order
Collapsed test in first differences	$\chi^2(2)$ 2.0019	=	0.3675	No autocorrelation of any order
Fully-collapsed portmanteau test	$\chi^2(1)$ 1.1570	=	0.2821	No autocorrelation of any order

As presented in Table 10, the Portmanteau test for autocorrelation yielded a Chi²(3) = 3.0000 with a p-value of 0.3916, while the collapsed tests in seasonal differences and first differences produced Chi² statistics of 2.0124 (p = 0.3656) and 2.0019 (p = 0.3675), respectively. The fully-collapsed portmanteau test also failed to reject the null hypothesis, with Chi²(1) = 1.1570 and p = 0.2821. Since all p-values are well above the 0.05 significance threshold, we fail to reject the null hypothesis of no autocorrelation in any of the tests. This confirms that the residuals in the panel data model are not serially correlated, thereby supporting the use of standard estimation techniques without the need for autocorrelation corrections.

Groupwise Heteroskedasticity Test

To further examine the assumption of constant variance of residuals across cross-sectional units (firms), the study applied the Modified Wald Test for Groupwise Heteroskedasticity in the context of a fixed effects regression model. This test is particularly useful for detecting whether different firms exhibit different levels of residual variance, which may not be captured by a global heteroskedasticity test.

Table 11: Modified Wald Test for Groupwise Heteroskedasticity

Test Description	Value
Null Hypothesis	Homoskedasticity: $\sigma_i^2 = \sigma^2$ for all i
Chi² (df = 7)	4.10
Prob > Chi²	**0.7682**

As reported in Table11, the test produced a Chi-square statistic of 4.10 with 7 degrees of freedom, and a p-value of 0.7682. Given that the p-value is substantially greater than the 0.05 significance threshold, we fail to reject the null hypothesis that the variances across the individual firms are equal. This result indicates that there is no evidence of groupwise heteroskedasticity in the fixed effects model, further confirming the appropriateness of the chosen regression structure. The consistency of this outcome with the earlier Breusch–Pagan test reinforces the robustness of the estimation

framework used in the subsequent empirical analysis.

Hausman Test for Model Selection

To determine the appropriate estimator between the Fixed Effects (FE) and Random Effects (RE) models, the study employed the Hausman specification test. This test evaluates whether the unique errors (u_i) are correlated with the regressors. Under the null hypothesis, the RE estimator is both efficient and consistent; under the alternative, only the FE estimator is consistent, and RE becomes inconsistent due to correlation with the individual effects.

Table 12: Hausman Test – Fixed Effects vs Random Effects

Variable	Fixed Effects (b)	Random Effects (B)	Difference (b−B)	Std. Error
S1	0.8424	-9.2177	10.0601	–
S2	-612.4982	710.0942	-1322.5924	427.6485
S3	50.4752	488.3899	-437.9147	–
SRS	-0.1606	0.1763	-0.3370	–
FS	0.4287	-0.0913	0.5200	0.3717
LEV	0.0788	-0.0000	0.0788	0.0234
ROA	0.0505	0.0231	0.0273	0.0328

Test Summary	**Value**
Null Hypothesis	Difference in coefficients not systematic
Chi^2 (df = 5)	8.30
Prob > Chi^2	**0.1405**
Note	(V_b − V_B is not positive definite)

Keys: TOBINQ – Tobin's Q, a proxy for firm value; S1 – Scope 1 Emissions Intensity; S2 – Scope 2 Emissions Intensity; S3 – Scope 3 Emissions Intensity; SRS – Sustainability Reporting Standard; FS – Firm Size; LEV – Leverage; and ROA – Return on Assets.

Source: Researchers' Computation (2025) using Stata 17

The Hausman test results in Table 12 indicate a Chi-square value of 8.30 (p = 0.1405), suggesting no significant systematic difference between the Fixed and Random Effects models. Therefore, the Random Effects (RE) model is preferred. Although the output flags a non-positive definite variance matrix (V_b − V_B)—which could signal issues like multicollinearity or coefficient scaling differences—this does not invalidate the test. Instead, it calls for cautious interpretation, but still supports using the RE model for estimating the relationships between carbon emissions, sustainability reporting, and firm value.

Correlation Analysis

Table 10 presents the Pearson correlation coefficients among the variables used in the study, including the dependent variable (firm value, proxied by TOBINQ), independent variables (Scope 1, Scope 2, Scope 3 carbon emissions and Sustainability Reporting Standard), and control variables (Firm Size, Leverage, and Return on Assets).

Table 13: Pearson Correlation Matrix (n = 24)

Variable	TOBINQ	S1	S2	S3	SRS	FS	LEV	ROA
TOBINQ	1.0000							
S1	0.0005	1.0000						
S2	0.8356	0.1029	1.0000					
S3	0.8338	0.0417	0.8323	1.0000				
SRS	0.0003	0.1765	-0.0729	-0.0103	1.0000			
FS	-0.1513	0.1579	0.0414	0.0788	0.3539	1.0000		
LEV	-0.2805	-0.6024	-0.2913	-0.1728	-0.0343	0.3268	1.0000	
ROA	0.6622	-0.2466	0.4774	0.5483	0.0668	-0.4661	-0.2352	1.0000

Keys: TOBINQ – Tobin's Q, a proxy for firm value; S1 – Scope 1 Emissions Intensity; S2 – Scope 2 Emissions Intensity; S3 – Scope 3 Emissions Intensity; SRS – Sustainability Reporting Standard; FS – Firm Size; LEV – Leverage; and ROA – Return on Assets.

Source: Researchers' Computation (2025) using Stata 17

The correlation analysis reveals that TOBINQ (firm value) is strongly and positively associated with Scope 2 and Scope 3 emissions, while showing a negligible relationship with Scope 1 emissions and sustainability reporting (SRS). Among control variables, ROA demonstrates a moderate positive correlation with TOBINQ, whereas firm size and leverage show weak negative associations. Notably, Scope 1 is negatively correlated with leverage, and ROA is positively linked to Scope 2 and 3, but negatively to firm size. These results support the need for regression analysis to explore the causal dynamics beyond these surface associations.

Conclusion of Diagnostic Tests and Justification for Model Selection

The study conducted several diagnostic tests to ensure the robustness and validity of its regression models. Normality tests revealed non-normal distributions, supporting the use of robust standard errors. Multicollinearity was not a concern, as VIF values were within acceptable limits. Heteroskedasticity was present, prompting the use of heteroskedasticity-robust estimators. No autocorrelation or model misspecification was detected. Although the Hausman test favored the Random Effects (RE) model, the Breusch–Pagan LM test suggested limited panel-level variation. Overall, the Robust Random Effects Panel Regression Model was selected as the most appropriate,

balancing efficiency with the correction of violations in model assumptions.

Regression Results and Interpretation

Table 14 presents the regression outcomes for four different estimation approaches: Ordinary Least Squares (OLS), Robust Regression, Random Effects (RE), and Fixed Effects (FE). Each model estimated the relationship between firm value (proxied by Tobin's Q) and carbon emission intensities (Scopes 1–3), sustainability reporting, and firm-specific control variables.

Table 14: Regression Results

Variable	Model 1: OLS	Model 2: Robust	Model 3: Random Effects	Model 4: Fixed Effects
S1	-9.2177 (0.918)	11.6759 (0.598)	-9.2177 (0.731)	0.8424 (0.991)
S2	710.0942 (0.035)	1955.778 (0.000)	710.0942 (0.000)	-612.4982 (0.207)
S3	488.3899 (0.090)	-805.8894 (0.068)	488.3899 (0.001)	50.4752 (0.695)
SRS	0.1763 (0.509)	0.0820 (0.237)	0.1763 (0.267)	-0.1606 (0.241)
FS	-0.0913 (0.359)	-0.0319 (0.201)	-0.0913 (0.081)	0.4287 (0.355)
LEV	-0.0000 (0.998)	0.0008 (0.740)	-0.0000 (0.996)	0.0788 (0.064)
ROA	0.0231 (0.454)	0.0535 (0.000)	0.0231 (0.431)	0.0505 (0.547)
_cons	2.5034 (0.190)	1.1912 (0.020)	2.5034 (0.008)	-13.2978 (0.175)
Observations	24	23	24	24
R-squared (Within)	–	–	0.0079	0.7079
R-squared (Between)	–	–	0.9905	0.2588
R-squared (Overall)	0.8266	–	0.8266	0.1104
Adjusted R-squared	0.7508	–	–	–
F / Wald Chi²	F(7,16) = 10.90	F(7,15) = 200.45	Wald $\chi^2(7) = 76.28$	F(6,6) = 3.46
Prob > F / Chi²	0.0000	0.0000	0.0000	0.0375
Sigma_u	–	–	0.0000	2.6291
Sigma_e	–	–	0.2913	0.2913
ρ (Rho: Variance due to u_i)	–	–	0.0000	0.9879

Keys: TOBINQ – Tobin's Q, a proxy for firm value; S1 – Scope 1 Emissions Intensity; S2 – Scope 2 Emissions Intensity; S3 – Scope 3 Emissions Intensity; SRS – Sustainability Reporting Standard; FS – Firm Size; LEV – Leverage; and ROA – Return on Assets.

Source: Researchers' Computation (2025) using Stata 17

Carbon Emissions and Firm Value

Across all models, Scope 2 emissions (S2) consistently showed a positive and statistically significant relationship with firm value, notably in the Random Effects model ($\beta = 710.09$, $p = 0.000$) and the Robust Regression model ($\beta = 1955.78$, $p = 0.000$). This suggests that firms with higher Scope 2 emissions per unit of revenue—possibly linked to energy usage—may also be larger or more productive, translating to higher market valuation. However, the Fixed Effects model returned an inverse and statistically insignificant coefficient for S2 ($\beta = -612.50$, $p = 0.207$), indicating that the significance may be driven more by cross-sectional variation than firm-level changes over time.

Scope 3 emissions (S3) were positively associated with firm value in the RE model ($\beta = 488.39$, $p = 0.001$), whereas a marginally negative but insignificant relationship appeared in the robust model ($\beta = -805.89$, $p = 0.068$). This divergence highlights model sensitivity to extreme values and unobserved heterogeneity.

Scope 1 emissions (S1) were not statistically significant in any model, indicating that direct emissions may have a more muted or non-linear impact on firm valuation within the Nigerian context.

Sustainability Reporting and Control Variables

The sustainability reporting score (SRS) did not exhibit significant influence on firm value in any specification. Despite showing a positive sign in OLS and RE models, all p-values exceeded 0.2, suggesting weak explanatory power. Firm Size (FS) and Leverage (LEV) yielded mixed results. LEV was borderline significant in the Fixed Effects model ($\beta = 0.0788$, $p = 0.064$), suggesting that higher leverage may contribute positively to firm value under certain conditions. FS became significant only in the RE model at the 10% level ($p = 0.081$), reinforcing the importance of accounting for between-firm variance. Return on Assets (ROA) was significant in the Robust Regression model ($\beta = 0.0535$, $p = 0.000$), underscoring the intuitive link between profitability and market valuation.

Model Diagnostics and Fit

The OLS and RE models both reported high overall explanatory power with $R^2 \approx 0.827$, while the FE model showed strong within-firm variation explained (R^2 within = 0.7079). The RE model also had the highest between R^2 (0.9905), suggesting strong cross-sectional explanatory power. However, the RE model assumes no correlation between unobserved firm effects and regressors—a condition validated by the earlier Hausman test.

Given its ability to accommodate firm-level heterogeneity, correct for heteroskedasticity, and maintain estimator efficiency, the Robust Random Effects Model was selected as the optimal specification for inference.

Robustness Checks

To validate the reliability of the regression results, the study conducted several robustness checks, including the use of clustered standard errors, robust regression, and residual diagnostics. The Random Effects model with firm-clustered robust errors confirmed the significance of Scope 2 and Scope 3 emissions, controlling for heteroskedasticity and autocorrelation. Robust regression further supported these findings by mitigating the impact of outliers, reaffirming the significance of Scope 2 and ROA. Residual analysis showed no major specification issues or non-linear patterns, and diagnostic tests (including the Ramsey RESET test) confirmed the model's validity. Overall, the robustness checks affirmed the stability and credibility of the key results.

Test of Hypotheses and Discussion of Findings

The study examined the effects of Scope 1–3 carbon emissions and sustainability reporting on firm value using the Robust Random Effects Panel Regression Model.

Scope 1 Emissions (S1)

The coefficient for Scope 1 was negative and statistically insignificant ($\beta = -9.2177$, $p = 0.731$), indicating that direct emissions have no meaningful impact on firm value. This aligns with Onoh et al. (2022), who found that weak or vague Scope 1 disclosures in Nigeria reduce their value relevance. However, it contrasts with Okike and Nwachukwu (2024) and Meqbel et al. (2025), who reported significant positive effects when Scope 1 data is disclosed within strong governance frameworks.

Scope 2 Emissions (S2)

A strong positive and highly significant relationship was observed between Scope 2 emissions and firm value ($\beta = 710.0942$, $p = 0.000$). This supports the findings of Aguguom (2024), who linked Scope 2 disclosures with improved investor perception, and Yuan and Bao (2025), who noted that normalized Scope 2 metrics are strong predictors of valuation, particularly in energy-intensive industries.

Scope 3 Emissions (S3)

Scope 3 also had a significant positive effect ($\beta = 488.3899$, $p = 0.001$), suggesting that value chain emissions are increasingly relevant to investors. This supports Emovon and Ogbonmwan (2025) and Tang et al. (2025), who found that transparent Scope 3

reporting improves firm reputation and valuation. The findings differ from Onoh et al. (2022), likely because this study focused only on firms that actively disclose Scope 3 data, reducing distortion from non-reporters.

Sustainability Reporting (SRS)

Although the sustainability reporting score had a positive coefficient ($\beta = 0.1763$), it was not statistically significant ($p = 0.267$), indicating limited influence on firm value. This partially aligns with Aguguom (2024), who highlighted inconsistencies in Nigerian ESG disclosures. While Easton et al. (2025) and Emovon and Ogbonmwan (2025) found positive valuation effects for structured sustainability reporting, the weak influence observed in this study suggests that many disclosures in Nigeria may lack sufficient depth, assurance, or alignment with global standards.

Summary

Overall, the findings reveal that Scope 2 and Scope 3 emissions significantly enhance firm value, likely reflecting investor awareness of operational and supply chain sustainability. In contrast, Scope 1 emissions and sustainability reporting had no significant impact, pointing to issues of disclosure quality and standardization in the Nigerian context.

Conclusion and Recommendations

This study examined the effect of carbon emissions disclosures—specifically Scope 1, Scope 2, and Scope 3 emissions—and sustainability financial reporting on the firm value of listed companies in Nigeria. Using a panel dataset from nine purposively selected firms over the period 2019–2023 and employing robust random effects panel regression, the study found that Scope 2 and Scope 3 emissions had significant positive impacts on firm value, while Scope 1 emissions and sustainability reporting were statistically insignificant. These findings suggest that indirect emissions and supply chain transparency are increasingly relevant to investor valuation, whereas direct emissions and ESG disclosures may not yet be systematically integrated into market assessments in Nigeria. The results highlight the growing importance of environmental accountability, particularly when disclosures are consistent, quantifiable, and aligned with international standards.

Based on the empirical findings, firms listed on the Nigerian Exchange Group should prioritize the disclosure of Scope 2 and Scope 3 emissions, ensuring such data is reliable, benchmarked, and clearly linked to sustainability strategies. While Scope 1 emissions are essential from an environmental standpoint, their disclosure should be strengthened in quality and assurance to improve market relevance. Additionally, companies should move beyond tokenistic sustainability reporting by aligning with

globally recognized frameworks such as IFRS S1/S2 and the GRI Standards, as these have a greater potential to influence investor perception and firm value. Regulators should also incentivize standardized ESG disclosures and promote third-party verification mechanisms to improve the credibility of sustainability reports.

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