

CARBON EMISSION DISCLOSURE AND FINANCIAL PERFORMANCE OF LISTED MANUFACTURING FIRMS IN NIGERIA

Adesanmi Timothy ADEGBAYIBI

Abstract

This study investigates whether carbon emission disclosure translates into improved financial performance in an emerging-market. Using firm-level panel data from 2015 to 2024, the study examines scope-specific disclosure, namely Scope 1 (direct emissions), Scope 2 (energy-related indirect emissions), and Scope 3 (value-chain emissions), and evaluates their implications for financial performance measured by return on assets (ROA) and return on equity (ROE). The study adopts an ex post facto research design and employs panel estimation techniques comprising pooled Ordinary Least Squares (OLS), Fixed Effects (FE), and Random Effects (RE) models, with firm size, earnings per share, and leverage included as control variables. Data were obtained from audited annual reports and sustainability disclosures of listed manufacturing firms in Nigeria. The findings reveal that Scope 2 disclosure has a negative and statistically significant relationship with both ROA and ROE. In contrast, Scope 1 and Scope 3 disclosures exhibit statistically insignificant relationships with financial performance. The study concludes that carbon emission disclosure alone does not automatically enhance firm performance, particularly in emerging economies characterized by weak environmental enforcement and infrastructural constraints. The study recommends that managers should complement carbon disclosure with substantive investments in energy efficiency and cleaner production technologies, while policymakers should strengthen environmental reporting standards and introduce supportive incentives like energy subsidies, tax reliefs to improve firms' sustainability and financial outcomes. The study contributes to the literature by providing Africa-specific evidence and by disaggregating carbon emission disclosure into Scope 1, Scope 2, and Scope 3 categories to reveal their heterogeneous financial implications.

Keywords: Carbon emission disclosure, financial performance, Scope 1, Scope 2, Scope 3, Manufacturing firms

1.0 Introduction

Climate change has emerged as one of the most pressing social and economic challenges of the twenty-first century, reshaping how firms are evaluated, regulated, and financed across global capital markets. Industrial activities, particularly within the manufacturing sector, remain a major source of carbon emissions, placing firms under increasing pressure to account for their environmental footprint. Beyond environmental degradation, unchecked emissions raise concerns about long-term economic sustainability, financial risk, and intergenerational equity. As investors, regulators, and civil society increasingly demand transparency around climate impacts, carbon emission disclosure has become a key component of corporate accountability frameworks. However, while disclosure is widely promoted as a mechanism for improving transparency and accountability, its financial implications for firms, particularly in emerging markets such as Nigeria, remain unclear.

Prior empirical studies have examined the relationship between carbon emissions, disclosure, and firm

performance, but the findings remain mixed. Some studies report positive associations, suggesting that carbon disclosure enhances corporate legitimacy, reduces perceived risk, and improves firm value (Gallego-Álvarez et al., 2015; Lee et al., 2016; Zhang et al., 2023). Other studies report negative effects, arguing that compliance costs, emission management expenses, and operational constraints may reduce profitability (Alvarez, 2012; Houqe et al., 2022; Laskar et al., 2022). A third stream finds weak or statistically insignificant relationships, particularly in developing economies where environmental reporting systems are still evolving and market responses to sustainability information are limited (Ganda & Milondzo, 2018; Miah et al., 2021). Importantly, most existing studies focus on aggregate emission measures or evidence from developed economies, leaving limited understanding of how different categories of emissions disclosure influence firm outcomes in Nigeria's manufacturing sector.

Against this backdrop, it is not clear whether carbon emission disclosure, disaggregated into Scope 1, Scope 2, and Scope 3 emissions, affect financial performance of listed manufacturing firms in Nigeria. This question is particularly relevant in Nigeria's manufacturing environment, where firms face increasing expectations for environmental transparency but continue to operate under challenges such as high production costs, unreliable energy supply, weak environmental monitoring systems, and limited access to cleaner production technologies. These conditions expose firms to both environmental and operational risks, making it important to examine whether disclosure practices are reflected in financial performance outcomes.

In Nigeria, listed manufacturing firms operate within a developing sustainability reporting framework characterized by gradual regulatory improvement and inconsistent enforcement of environmental disclosure standards. Despite increasing attention to sustainability reporting, empirical evidence remains limited and inconclusive regarding whether carbon emission disclosure improves or weakens financial performance in this sector. This uncertainty forms the central motivation for this study.

This study is based on firm-level data of listed manufacturing companies in Nigeria covering the period 2015–2024. It employs panel estimation techniques to examine the relationship between scope-specific carbon emission disclosure and financial performance, measured using return on assets (ROA) and return on equity (ROE). By separating carbon disclosure into Scope 1, Scope 2, and Scope 3 emissions, the study provides a more detailed assessment of how different emission categories relate to firm performance, rather than treating emissions as a single aggregated measure.

The study is relevant to key stakeholders in corporate reporting and financial decision-making. For corporate managers, the findings provide evidence on whether environmental disclosure is associated with improved profitability or financial efficiency, thereby informing decisions on environmental reporting strategies, energy efficiency investments, and operational cost management. For financial analysts and credit providers, the study provides insights into whether carbon disclosure serves as useful information for evaluating firm performance and risk. For regulators and standard setting bodies, the findings offer evidence on whether disclosure requirements can improve corporate transparency without undermining firm financial outcomes.

This provides specific Nigeria empirical evidence on the relationship between carbon emission disclosure and financial performance in the manufacturing sector, thereby filling a context specific gap in the literature. Also, by distinguishing between Scope 1, Scope 2, and Scope 3 emissions, the study offers a more detailed understanding of how different emission categories relate to financial outcomes. Furthermore, the study contributes to institutional understanding by examining how carbon disclosure interacts with Nigeria's emerging regulatory environment, characterized by evolving environmental reporting practices, energy constraints, and varying levels of disclosure compliance. The findings further clarify under what conditions carbon emission disclosure is associated with financial performance outcomes in Nigerian listed manufacturing firms. Overall, the study provides empirical evidence that can support corporate decision making, financial analysis, and regulatory development in relation to carbon-related corporate reporting.

2.0 Literature Review

2.1 Conceptual Review

2.1.1 Financial Performance

Financial performance represents firm's ability to efficiently deploy its resources to generate economic returns and sustain operations over time. In the accounting, finance, and sustainability literature, financial performance is widely conceptualized as a multidimensional construct reflecting profitability, efficiency, and returns to capital providers. Recent empirical studies increasingly emphasize financial performance as both an outcome of managerial decision-making and a channel through which environmental and sustainability strategies manifest economic consequences (Alvarez, 2012; Lee, Min, & Yook, 2015). In this sense, financial performance serves as a critical benchmark for assessing whether environmental accountability mechanisms, such as carbon emission disclosure, impose costs, generate efficiency gains, or alter firms' risk return profiles.

In sustainability oriented research, financial performance is commonly examined using accounting-based measures because they reflect firms' internal operating outcomes. Measures such as return on assets (ROA) and return on equity (ROE) as core indicators of financial performance, as they capture asset utilization efficiency and shareholder returns within firms' operational structures (Zhang et al., 2023; Kabir et al., 2024; Persakis, 2024; Wang et al., 2025). These measures remain particularly relevant in contemporary empirical studies because they provide stable, comparable indicators of firm level performance, especially in emerging economies where market based measures may be more volatile or less informative.

For manufacturing firms, ROA and ROE are especially appropriate due to the sector's capital intensive operations and persistent exposure to cost pressures arising from energy consumption, production inefficiencies, and environmental compliance requirements. Recent evidence further suggests that financial performance in carbon intensive sectors is closely linked to how firms manage environmental risks and disclose sustainability related information (Lee & Zhou, 2023; Ahmed & Green, 2025). Conceptually, therefore, financial performance in this study is viewed as the observable economic outcome through which the effects of carbon emission disclosure are assessed.

2.2 Carbon Emission

Carbon emission refers to the release of greenhouse gases, particularly carbon dioxide, arising from firms' production processes, energy consumption, and broader operational and supply-chain activities. In recent sustainability and environmental finance literature, carbon emissions are increasingly viewed not merely as environmental externalities but as economically significant factors capable of influencing regulatory exposure, operational costs, investor perception, corporate reputation, and firm risk (Zhang et al., 2023; Persakis, 2024; Wang et al., 2025). As global climate concerns continue to intensify, carbon emissions have become central to debates on corporate accountability, sustainability reporting, and long-term value creation, especially within carbon-intensive sectors such as manufacturing.

In this study, carbon emission is conceptualized through the prism of corporate disclosure, reflecting firms' willingness to communicate information about their emission profiles rather than the absolute volume of emissions generated. This disclosure-oriented view is consistent with recent empirical work showing that transparency around carbon emissions whether related to direct operations, energy use, or value-chain activities an influence stakeholder evaluations and financial outcomes, even when emission reduction is gradual (Hardiyansah & Agustini, 2021; Persakis, 2024). By focusing on disclosure across emission scopes, carbon emission is treated as a governance and strategic signaling mechanism that captures how firms respond to climate-related expectations and institutional pressures, particularly in emerging market contexts where quantitative emission data may be incomplete or unevenly enforced (Miah et al., 2021; Laskar et al., 2022).

2.3 Theoretical Review and Hypothesis Development

This study is anchored primarily on legitimacy theory, while drawing selectively on insights from stakeholder theory and signaling theory to extend the understanding of the study. The choice of legitimacy theory is motivated by the nature of carbon emission disclosure as a socially constructed corporate response to environmental scrutiny rather than a purely efficiency-driven managerial decision (Suchman, 1995; Deegan, 2002). In emerging economies such as Nigeria, where formal environmental enforcement is evolving, firms' disclosure of carbon related information is best understood as a strategic effort to maintain societal approval, protect organizational survival, and manage external perceptions. Legitimacy theory guides this study by providing a framework for understanding how firms use carbon emission disclosure to respond to societal expectations and maintain organizational legitimacy. By differentiating between Scope 1, Scope 2, and Scope 3 disclosures, the theory helps explain how different forms of environmental disclosure may relate differently to firms' financial performance outcomes.

From the perspective adopted in this study, legitimacy is not a binary condition but a dynamic resource that firms continuously negotiate with their institutional environment (Suchman, 1995). Manufacturing firms in Nigeria operate under increasing pressure from regulators, international supply chains, lenders, and sustainability-oriented investors, even in the absence of binding domestic carbon regulations. Carbon emission disclosure thus becomes a mechanism through which firms attempt to align their operations with evolving societal norms around environmental responsibility (Deegan & Unerman, 2011). However, legitimacy theory does not assume that all legitimacy-seeking actions generate immediate economic benefits. Instead, it predicts that the financial consequences of disclosure depend on whether stakeholders interpret such actions as credible, substantive, and aligned with firms' operational realities. This theoretical view is particularly relevant in explaining why certain disclosures may have weak, null, or even adverse effects on financial performance.

Legitimacy theory is based on the proposition that organizations continually seek to ensure that their activities are perceived as consistent with the values, norms, and expectations of the society in which they operate. The theory assumes that firms depend on societal approval for continued survival and access to critical resources, and as such, they adopt disclosure strategies to demonstrate accountability, transparency, and conformity with societal expectations (Suchman, 1995). Within the context of environmental reporting, legitimacy theory suggests that firms disclose environmental and carbon-related information in order to maintain, protect, or repair legitimacy when stakeholders perceive environmental risks or irresponsible corporate behavior. The theory further proposes that disclosure practices may influence stakeholders' perceptions of firms, thereby affecting economic outcomes such as reputation, investor confidence, regulatory relations, and ultimately financial performance.

Guided by these propositions, this study applies legitimacy theory to Scope 1 carbon emission disclosure by conceptualizing direct emissions reporting as a signal of operational transparency regarding firms' core production activities. Scope 1 disclosure directly reveals the environmental impact associated with firms' internal operations and may enhance legitimacy by demonstrating environmental accountability and responsiveness to stakeholder concerns. However, the theory also suggests that the financial implications of such disclosure may not always be positive. This is because extensive disclosure of direct emissions can expose firms to increased stakeholder scrutiny, reputational concerns, regulatory attention, and perceptions of high environmental compliance costs, particularly in carbon-intensive manufacturing industries. Consequently, legitimacy theory indicates that the relationship between Scope 1 disclosure and financial performance may be mixed, depending on whether stakeholders interpret the disclosure as evidence of responsible environmental management or as an indication of significant environmental risk and operational inefficiency.

For Scope 2 disclosure, legitimacy theory is extended to account for the structural constraints of energy systems in developing economies. Scope 2 emissions reflect firms' dependence on external energy sources, which in Nigeria are often costly, carbon-intensive, and unreliable. Disclosure in this domain may inadvertently highlight firms' exposure to systemic energy inefficiencies rather than managerial failure per se. From a legitimacy standpoint, such disclosure can undermine performance if stakeholders interpret high energy-related emissions as indicators of weak environmental adaptability or rising

operational risk (Hahn et al., 2015). Thus, this study theorizes that Scope 2 disclosure may generate legitimacy costs in settings where clean energy alternatives and policy incentives are limited, leading to potential negative financial outcomes.

The application of legitimacy theory to Scope 3 disclosure requires further theoretical development, as value-chain emissions extend beyond firms' direct control. In this study, Scope 3 disclosure is viewed as a forward-looking legitimacy strategy aimed at aligning firms with global sustainability norms and supply-chain expectations (Bebbington et al., 2014). However, because Scope 3 emissions are difficult to measure, verify, and manage especially in fragmented supply networks typical of emerging markets stakeholders may discount such disclosures due to concerns about credibility and reliability (Boiral, 2016). Legitimacy theory therefore suggests that Scope 3 disclosure may have weak or delayed financial relevance, as legitimacy gains accrue gradually and depend on the firm's capacity to influence upstream and downstream partners. This perspective helps explain why Scope 3 disclosure often fails to produce immediate performance effects despite its strategic importance in global sustainability discourse.

While legitimacy theory provides the primary explanatory lens, stakeholder theory complements the analysis by clarifying the channels through which legitimacy pressures arise. Stakeholder theory emphasizes that firms are accountable not only to shareholders but also to a broader set of actors including regulators, lenders, customers, employees, and international partners whose expectations increasingly encompass environmental responsibility (Freeman, 1984; Donaldson & Preston, 1995). In the context of this study, carbon emission disclosure is interpreted as a response to heterogeneous stakeholder demands, with different stakeholder groups attaching varying importance to different emission scopes. This helps explain why financial markets may react unevenly to Scope-specific disclosures and why disclosure does not uniformly translate into improved financial performance.

Finally, signaling theory enriches the framework by addressing information asymmetry in emerging capital markets. Carbon disclosure can act as a signal of superior environmental awareness, governance quality, or long-term strategic orientation (Spence, 1973). However, signaling theory also cautions that signals are effective only when they are costly to imitate and perceived as credible. In Nigeria's manufacturing sector, where disclosure standards vary and external assurance is limited, the signaling value of carbon disclosure may be diluted, reducing its immediate impact on firm performance (Connelly et al., 2011). This theoretical insight reinforces the study's expectation that the financial effects of carbon disclosure are conditional rather than automatic, shaped by credibility, enforcement, and institutional trust.

2.4 Empirical Review

2.4.1 *Scope 1 Disclosure and Financial Performance*

Recent empirical work has increasingly examined whether firms' disclosure of Scope 1 (direct) emissions is reflected in financial outcomes, but the evidence remains far from settled, largely because studies differ in whether they treat carbon as a disclosure signal, an operational efficiency proxy, or a risk factor priced by markets. A first stream of recent studies leans toward a positive association, arguing that transparent carbon-related reporting especially when tied to internal capability building can strengthen stakeholder confidence, reduce reputational risk, and support performance improvements. For example, evidence suggests that firms that embed environmental training and capability development alongside carbon management tend to report better performance outcomes, implying that disclosure may be more value-relevant when it signals genuine managerial commitment rather than symbolic compliance (Khatib et al., 2023). Related work highlights the role of complementary governance and organizational conditions in shaping whether carbon-related practices translate into performance gains, with some studies documenting that firm characteristics and governance configurations can produce heterogeneous but sometimes beneficial performance responses to carbon strategies (Bouaddi et al., 2023). In a similar direction, research that explicitly incorporates climate-related risk considerations into performance models tends to support the view that proactive climate disclosure and management can act as a protective mechanism, stabilizing firm outcomes where risk mitigation is credible and institutional pressures are non-trivial (Dinh et al., 2024).

However, a second stream finds a negative performance link, often interpreting direct-emissions-related disclosure as a marker of higher operating exposure and compliance costs, particularly when carbon-intensive processes raise agency frictions and financing constraints. Studies in this camp show that higher carbon burdens are associated with weaker performance, especially where agency costs rise and monitoring becomes more complex, undermining efficient resource allocation (Houque et al., 2022). Others argue that climate-policy uncertainty can depress performance by complicating planning horizons and increasing risk premia, causing market participants to treat carbon-intensive operational footprints as financially adverse even when disclosure improves transparency (Persakis, 2024). Reinforcing this risk-channel argument, firm-level evidence linking carbon outcomes to default and credit risk suggests that carbon-intensive profiles can weaken performance metrics through higher funding costs and risk perception (Kabir et al., 2021). A third strand reports mixed or insignificant effects, suggesting that the Scope 1 disclosure–performance relationship may be conditional on institutional quality, enforcement strength, and disclosure credibility, particularly in emerging markets where investors may discount environmental information (Miah et al., 2021; Chou et al., 2025).

H₁: Scope 1 carbon emission disclosure has an effect on the financial performance of listed manufacturing firms.

2.4.2 Scope 2 Disclosures and Financial Performance

The literature linking Scope 2 (energy-related indirect) emissions disclosure to financial performance has grown rapidly in recent years, reflecting the central role of energy consumption in cost structures and transition policy exposure. One strand of studies reports positive performance effects, particularly in contexts where carbon pricing mechanisms, emissions trading schemes, or energy efficiency incentives are effectively implemented. Evidence from emissions trading regimes suggests that regulatory pressure can stimulate innovation and efficiency improvements that enhance firm performance, supporting the argument that Scope 2 disclosure may signal adaptive capability rather than cost exposure (Ren et al., 2022). Related empirical findings from China’s carbon emissions trading policy indicate that firms can simultaneously improve environmental outcomes and financial performance when policy frameworks reduce uncertainty and reward cleaner energy use (Sun et al., 2024). International studies further suggest that structured transition environments enable firms to internalize energy-related disclosures into strategic decision-making, producing favorable performance outcomes over time (Vu et al., 2025).

Conversely, a substantial body of work documents a negative association between energy-related emissions and firm performance, especially in settings characterized by high energy costs, unreliable power supply, and limited access to clean energy alternatives. Studies examining pollution-reduction financing policies find that compliance and adjustment costs can outweigh efficiency gains, leading to reduced profitability where firms face financial constraints (Zhang & Vigne, 2021). Similarly, evidence from emerging markets shows that the performance implications of Scope 2-related pressures are uneven, with some firms experiencing adverse effects due to sectoral differences and limited absorptive capacity (Sun et al., 2022). A third strand emphasizes heterogeneous and mixed outcomes, arguing that Scope 2 disclosure may simultaneously capture operational efficiency and structural vulnerability, depending on firm size, industry positioning, and institutional support (Zhang & Gan, 2024; Ghose et al., 2023). These findings suggest that the financial relevance of Scope 2 disclosure is highly context-dependent and sensitive to energy market conditions.

H₂: Scope 2 carbon emission disclosure has an effect on the financial performance of listed manufacturing firms.

2.4.3 Scope 3 Disclosures and Financial Performance

Empirical research on Scope 3 (value-chain) emissions disclosure has expanded markedly in recent years as value-chain carbon exposure is increasingly viewed as a strategic and financial risk. A first stream of studies reports positive performance relationships, emphasizing that supply-chain decarbonisation and transition alignment can enhance competitiveness and long-term value creation. Evidence on carbon neutrality strategies suggests that firms integrating value-chain emissions into strategic planning can achieve performance gains through innovation, supply-chain coordination, and

improved stakeholder relationships (Zhang et al., 2023). Related studies argue that Scope 3 initiatives are more likely to improve performance when firms face fewer financial constraints, as adequate resources enable effective supplier engagement and monitoring (Zhang & Lucey, 2022). Empirical findings on green investment further support the view that forward-looking environmental strategies, including supply-chain initiatives, can enhance firm outcomes when aligned with operational efficiency (Chen & Ma, 2021).

In contrast, another stream reports negative performance effects, highlighting the high costs, coordination challenges, and data reliability issues associated with managing and disclosing value-chain emissions. Studies on carbon productivity indicate that firms embedded in carbon-intensive supply networks may experience performance penalties when Scope 3 exposure is high and difficult to mitigate in the short term (Laskar et al., 2022). Climate policy uncertainty further complicates this relationship, as long-horizon supply-chain commitments may be discounted by investors when regulatory trajectories are unclear (Persakis, 2024). A third body of work documents weak or insignificant relationships, attributing null effects to measurement challenges, low comparability, and limited assurance of Scope 3 disclosures. Recent evidence suggests that while governance mechanisms influence emissions outcomes, the translation of Scope 3 disclosure into immediate financial performance is often muted due to factors beyond managerial control (Fan et al., 2023). Similar conclusions are drawn in studies showing that the value relevance of carbon disclosure depends heavily on disclosure credibility and environmental performance quality (Hardiyansah & Agustini, 2021).

H₃: Scope 3 carbon emission disclosure has an effect on the financial performance of listed manufacturing firms.

3.0 Methodology

3.1 Research Design, Population, and Sources of Data

This study adopts an *ex post facto* research design, which is appropriate where variables are observed without any form of manipulation by the researcher. The design is widely used in accounting and sustainability research because corporate disclosure practices and financial outcomes are historical in nature and cannot be experimentally controlled. The population of the study comprises all 59 manufacturing firms listed on the Nigerian Exchange Group (NGX) as at the end of the study period. From this population, a final sample of 46 manufacturing firms was selected using a purposive sampling technique, based on data availability, consistency of listing status, and accessibility of annual reports over the study horizon. The period of analysis spans from 2015 to 2024. This period coincides with increased global attention to climate-related disclosure and sustainability reporting following major international sustainability initiatives such as the adoption of the Paris Climate Agreement in 2015 and the growing implementation of environmental, social, and governance (ESG) reporting frameworks across global markets. During this period, firms operating in carbon-intensive sectors also experienced increasing pressure from regulators, investors, and other stakeholders to improve transparency regarding environmental and carbon-related activities. The study relied on secondary data obtained from firms' audited annual reports and sustainability disclosures, ensuring consistency, reliability, and comparability across firms and periods.

3.2 Method of Data Analysis

The empirical analysis is conducted using panel data estimation techniques, which allow for the exploitation of both cross-sectional and time-series variations in the data. Panel methods are particularly suitable in this context because they control for unobserved firm-specific characteristics that may influence both carbon emission disclosure practices and financial performance. The study initially estimates pooled Ordinary Least Squares (OLS) models for baseline insights, after which Fixed Effects (FE) and Random Effects (RE) estimators are employed to examine the relationship between the variables. Diagnostic tests, including Hausman specification test, are used to determine the most appropriate estimator for each model. The use of FE and RE models is consistent with prior empirical

studies examining the relationship between carbon emissions and firm performance in emerging and developed markets (Matsumura et al., 2014; Miah et al., 2021).

3.3 Model Specification

To examine the effect of carbon emission disclosure on firm performance, two separate econometric models are specified based on the alternative measures of financial performance. The first model captures asset-based performance, while the second focuses on equity-based performance, thereby providing a more comprehensive assessment of firm outcomes.

The ROA model is specified as follows:

$$ROA_{it} = \beta_0 + \beta_1 SC1_{it} + \beta_2 SC2_{it} + \beta_3 SC3_{it} + \beta_4 FSZ_{it} + \beta_5 EPS_{it} + \beta_6 LEV_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

The ROE model for estimate robustness check is specified as:

$$ROE_{it} = \beta_0 + \beta_1 SC1_{it} + \beta_2 SC2_{it} + \beta_3 SC3_{it} + \beta_4 FSZ_{it} + \beta_5 EPS_{it} + \beta_6 LEV_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

where i denotes firm i , t denotes year t , μ_i captures unobserved firm-specific effects, and ε_{it} represents the idiosyncratic error term.

3.4 Measurement of Variables

Firm performance, the dependent variable of the study, is measured using return on assets (ROA) and return on equity (ROE). ROA is computed as profit after tax divided by total assets and reflects management's efficiency in utilizing firm resources to generate earnings. ROE, calculated as profit after tax divided by shareholders' equity, captures the returns accruing to equity holders and is particularly relevant from an investor perspective. These accounting-based performance measures are extensively used in prior studies examining the financial implications of environmental practices and carbon-related disclosures because they capture internal operating performance rather than market sentiment alone (Alvarez, 2012; Gallego-Álvarez et al., 2015; Houque et al., 2022).

The key independent variables are carbon emission disclosures, operationalized using Scope 1 (SC1), Scope 2 (SC2), and Scope 3 (SC3) emission categories in line with international reporting frameworks such as the Greenhouse Gas Protocol. Scope 1 disclosure represents information on direct emissions arising from a firm's owned or controlled sources, Scope 2 disclosure captures indirect emissions from purchased electricity and energy consumption, while Scope 3 disclosure relates to other indirect emissions occurring along the firm's value chain. Consistent with prior disclosure-based studies, each scope is measured using a binary dummy variable, taking a value of 1 if the firm discloses information relating to that emission scope in its annual or sustainability report, and 0 otherwise. The use of disclosure dummies is particularly appropriate in emerging markets where quantitative emission data are often unavailable, inconsistent, or unaudited (Matsumura et al., 2014; Cucchiella et al., 2017; Miah et al., 2021).

To isolate the effect of carbon emission disclosure on financial performance, the study controls for firm-specific characteristics that are known to influence profitability. Firm size (FSZ) is measured as the natural logarithm of total assets and controls for scale effects, resource availability, and market power, which may affect both disclosure practices and performance outcomes (Lee & Min, 2015). Earnings per share (EPS), measured as profit attributable to ordinary shareholders divided by the number of outstanding shares, captures profitability and earnings capacity and is included to account for firms' underlying financial strength. Leverage (LEV) is measured as the ratio of total debt to total assets and reflects firms' financing structure and exposure to financial risk, which may constrain both environmental investments and performance (Houque et al., 2022; Ganda & Milondzo, 2018). The inclusion of these control variables enhances the robustness of the estimated models and aligns the study with best practices in high-impact accounting and sustainability research.

4.0 Results and Discussions

This study examines the effect of carbon emission disclosure on the financial performance of listed

manufacturing firms in Nigeria over the period 2015–2024. In this study, carbon emission disclosure is operationalized using Scope 1 (SC1), Scope 2 (SC2), and Scope 3 (SC3) emissions as proxies for the key explanatory variables, reflecting direct emissions, energy-related indirect emissions, and other indirect emissions, respectively. Financial performance, the dependent variable, is measured using return on assets (ROA) and return on equity (ROE), capturing both asset-based efficiency and shareholders' return. To enhance the robustness and explanatory strength of the empirical model, firm size (FSZ), earnings per share (EPS), and leverage (LEV) are included as control variables. This section presents the pre-estimation diagnostics, including descriptive statistics and correlation analysis, followed by the panel regression results and hypothesis testing, which evaluate the direction, magnitude, and statistical significance of the relationships among carbon emission disclosure components and financial performance.

4.1 Descriptive Statistics

This section presents summary statistics for the key explanatory and dependent variables employed in the study. Specifically, the mean, standard deviation, minimum, and maximum values are reported to describe the distribution and variability of carbon emission disclosure measures as well as financial performance indicators. Table 4.1 reports the descriptive statistics for all variables included in the empirical analysis.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
roa	460	-0.009	29.656	-378.940	108.900
roe	460	4.647	77.355	-444.910	480.550
sc1	460	0.861	0.346	0.000	1.000
sc2	460	0.783	0.413	0.000	1.000
sc3	460	0.754	0.431	0.000	1.000
fsz	460	7.238	1.009	4.620	9.590
eps	460	1.973	8.648	-48.520	57.630
lev	460	71.031	47.669	2.010	424.170

Source: Author's Computation, (2026)

Table 1 presents the descriptive statistics of financial performance and carbon emission disclosure variables for listed manufacturing firms in Nigeria over the study period. The results show that the mean return on assets (ROA) is slightly negative (-0.009), suggesting that, on average, sampled firms experienced marginal inefficiencies in asset utilization during the period. However, the large standard deviation (29.656) and wide range between the minimum (-378.940) and maximum (108.900) values indicate substantial heterogeneity in firms' operating performance, reflecting periods of severe losses and strong profitability across firms and years. Similarly, return on equity (ROE) records a positive mean of 4.647 but with a very high standard deviation (77.355) and extreme minimum and maximum values, implying pronounced volatility in shareholders' returns. This wide dispersion in ROE highlights the unstable earnings environment facing Nigerian manufacturing firms, possibly driven by macroeconomic shocks, cost pressures, exchange rate volatility, and varying financial structures over the sample period.

With respect to carbon emission disclosure, the mean values of Scope 1 (SC1), Scope 2 (SC2), and Scope 3 (SC3) disclosures are relatively high at 0.861, 0.783, and 0.754, respectively, suggesting that a substantial proportion of firms disclose information on direct and indirect carbon emissions. Nonetheless, the standard deviations indicate notable cross-sectional differences in disclosure practices, while the minimum values of zero confirm that some firms still provide no carbon emission disclosures, particularly for Scope 3 emissions. This pattern is consistent with the higher measurement complexity and data requirements associated with value-chain emissions. Among the control variables, firm size (FSZ) shows moderate dispersion, indicating the presence of both medium-sized and large manufacturing firms in the sample. Earnings per share (EPS) exhibits considerable variability with negative minimum values. This is pointing to loss making firms, while leverage (LEV) displays extreme dispersion, suggesting that some firms are highly debt dependent.

Overall, the descriptive statistics reveal significant variation in both financial performance and carbon emission disclosure practices, providing a suitable basis for examining their empirical relationship in subsequent regression analyses.

4.2 Correlation Analysis

To examine the association among carbon emission disclosure measures and financial performance indicators, this study employs the Spearman rank correlation coefficient. The resulting correlation matrix, presented in the table 2, provides preliminary evidence on the direction and strength of the relationships among Scope 1 (SC1), Scope 2 (SC2), Scope 3 (SC3) disclosures, return on assets (ROA), return on equity (ROE), and the control variables.

Table 2: Correlation Analyses

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) roa	1.000							
(2) roe	0.729	1.000						
(3) sc1	-0.009	0.033	1.000					
(4) sc2	0.018	-0.048	0.550	1.000				
(5) sc3	0.011	0.035	0.486	0.507	1.000			
(6) fsz	0.350	0.247	0.101	0.338	0.279	1.000		
(7) eps	0.814	0.651	0.175	0.187	0.207	0.499	1.000	
(8) lev	-0.302	-0.068	-0.106	-0.177	0.041	-0.024	-0.305	1.000

Source: Author's Computation, (2026)

Spearman correlation matrix was used in this study because the carbon emission disclosure variables and financial performance measures may not satisfy the normality assumption required for parametric correlation techniques, making Spearman correlation more appropriate for measuring the strength and direction of their association. Table 2 presents the Spearman correlation matrix showing the bivariate relationships among carbon emission disclosure measures, financial performance indicators, and control variables for listed manufacturing firms in Nigeria. The results indicate a strong positive association between return on assets (ROA) and financial performance (ROE) ($\rho = 0.729$), suggesting that firms that utilize their assets efficiently also tend to generate higher returns for shareholders. ROA exhibits a strong positive correlation with earnings per share (EPS) ($\rho = 0.814$), while ROE is also positively associated with EPS ($\rho = 0.651$), highlighting the central role of profitability in driving firm performance. Firm size (FSZ) shows moderate positive correlations with both ROA ($\rho = 0.350$) and ROE ($\rho = 0.247$), implying that larger manufacturing firms may benefit from scale advantages, better resource allocation, and stronger market positioning. In contrast, leverage (LEV) is negatively correlated with ROA ($\rho = -0.302$) and ROE ($\rho = -0.068$), suggesting that higher debt levels may exert downward pressure on financial performance, particularly in an environment characterized by high financing costs.

Regarding carbon emission disclosure, the correlations between Scope 1 (SC1), Scope 2 (SC2), Scope 3 (SC3) disclosures and financial performance measures are generally weak, indicating that the performance implications of carbon disclosure are not immediately apparent at the bivariate level. Nonetheless, the carbon disclosure variables are moderately and positively correlated with one another, particularly between SC1 and SC2 ($\rho = 0.550$), SC1 and SC3 ($\rho = 0.486$), and SC2 and SC3 ($\rho = 0.507$), suggesting a degree of consistency in firms' disclosure practices across emission scopes. Importantly, none of the correlation coefficients among the explanatory variables are excessively high, indicating the absence of serious multicollinearity concerns. Overall, the correlation analysis provides preliminary insights into the relationships among the variables and justifies the use of multivariate regression analysis to further explore the impact of carbon emission disclosure on financial performance while controlling for firm-specific characteristics.

4.3 Regression Analyses

This section presents the regression analyses conducted to examine the effect of carbon emission disclosure on the financial performance of listed manufacturing firms in Nigeria. The analysis begins with the estimation of an Ordinary Least Squares (OLS) regression model to provide preliminary evidence on the relationship between carbon emission disclosure, measured using Scope 1 (SC1), Scope 2 (SC2), and Scope 3 (SC3), and financial performance indicators, return on assets (ROA) and return on equity (ROE). To ensure the validity of the OLS estimates, relevant diagnostic tests, including checks for heteroscedasticity and multicollinearity, were performed.

Table 3: Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	OLS-ROA	FE-ROA	RE-ROA	OLS-ROE	FE-ROE	RE-ROE
sc1	1.970 (0.655)	2.011 (0.714)	1.885 (0.706)	14.146 (0.233)	27.615 (0.101)	18.283 (0.171)
sc2	-14.372*** (0.000)	-9.222 (0.136)	- (0.006)	-35.114*** (0.001)	-35.575 (0.060)	- (0.007)
sc3	-1.400 (0.684)	-0.286 (0.952)	0.468 (0.909)	0.369 (0.968)	-6.734 (0.640)	-2.571 (0.810)
Fsz	7.949*** (0.000)	23.122*** (0.000)	9.619*** (0.000)	10.003*** (0.005)	11.722 (0.354)	10.707** (0.020)
Eps	1.090*** (0.000)	2.044*** (0.000)	1.625*** (0.000)	3.532*** (0.000)	3.698*** (0.000)	3.572*** (0.000)
Lev	-0.134*** (0.000)	-0.113*** (0.001)	-0.114*** (0.000)	-0.170** (0.021)	-0.009 (0.931)	-0.116 (0.160)
Intercept	-39.568*** (0.000)	-157.694*** (0.000)	- (0.000)	-47.639 (0.085)	-77.697 (0.411)	-58.138 (0.101)
Observations	460.000	460.000	460.000	460.000	460.000	460.000
Overall R2	0.285	0.223	0.249	0.223	0.200	0.209
Chi2						83.419
Breusch-Pagan/Cook-Weisberg Test	868.92 {0.0000}			65.98 {0.0000}		
VIF	1.42			1.42		
Hausman		13.69 {0.0333}			3.73 {0.7133}	

Table 3 presents the regression results obtained from the Ordinary Least Squares (OLS), Fixed Effects (FE), and Random Effects (RE) estimations for return on assets (ROA) and return on equity (ROE). The interpretation focuses primarily on the preferred models selected through the Hausman specification test. Since the Hausman test for the ROA model is statistically significant ($\chi^2 = 13.69$; $p = 0.0333$), the Fixed Effects model is considered the most appropriate estimator for ROA. Conversely, the Random Effects model is preferred for the ROE specification because the Hausman test is insignificant ($\chi^2 = 3.73$; $p = 0.7133$).

For the ROA Fixed Effects model, Scope 1 carbon emission disclosure (SC1) has a positive coefficient of 2.011 but remains statistically insignificant ($p = 0.714$). This implies that firms disclosing direct emissions tend to record approximately 2.01 units increase in return on assets relative to non-disclosing firms; however, the effect is not statistically strong enough to conclude that Scope 1 disclosure significantly influences asset-based financial performance. Scope 2 disclosure (SC2) records a negative coefficient of -9.222 with an insignificant p -value (0.136), indicating that energy-related emission disclosure is associated with a reduction in ROA by about 9.22 units, although the relationship is not statistically significant under the fixed effects specification. Scope 3 disclosure (SC3) also exhibits an

insignificant relationship with ROA, with a coefficient of -0.286 ($p = 0.952$), suggesting that value-chain emission disclosure exerts no meaningful effect on firms' asset utilization efficiency.

Among the control variables, firm size (FSZ) has a positive and statistically significant coefficient of 23.122 ($p < 0.01$), indicating that larger firms tend to achieve stronger asset-based financial performance. Specifically, a one-unit increase in firm size is associated with approximately 23.12 units increase in ROA. Earnings per share (EPS) also demonstrates a positive and highly significant coefficient of 2.044 ($p < 0.01$), implying that more profitable firms record improved returns on assets. In contrast, leverage (LEV) has a negative and statistically significant coefficient of -0.113 ($p < 0.01$), suggesting that higher debt levels reduce firms' asset-based profitability.

For the ROE Random Effects model, Scope 1 disclosure (SC1) has a positive coefficient of 18.283 but remains statistically insignificant ($p = 0.171$), indicating that direct emissions disclosure does not significantly influence shareholders' returns. Scope 2 disclosure (SC2), however, records a negative and statistically significant coefficient of -34.913 ($p < 0.01$). This implies that firms disclosing energy-related indirect emissions experience approximately 34.91 units reduction in return on equity relative to firms that do not disclose such emissions. The result suggests that energy-related disclosure may expose firms to substantial operational and cost pressures within the Nigerian manufacturing environment. Scope 3 disclosure (SC3) records a negative but insignificant coefficient of -2.571 ($p = 0.810$), indicating that value-chain emission disclosure does not significantly affect shareholders' returns.

With respect to the control variables in the ROE model, firm size (FSZ) has a positive and statistically significant coefficient of 10.707 ($p < 0.05$), suggesting that larger firms are more likely to generate higher returns to shareholders. Earnings per share (EPS) equally exhibits a positive and highly significant relationship with ROE, with a coefficient of 3.572 ($p < 0.01$), implying that improved earnings performance translates directly into higher shareholder returns. Leverage (LEV), although negative (-0.116), is statistically insignificant ($p = 0.160$), suggesting that debt financing does not significantly influence equity-based performance in the sampled firms.

Overall, the regression results reveal that Scope 2 carbon emission disclosure exerts the most economically meaningful effect on financial performance, particularly on return on equity, while Scope 1 and Scope 3 disclosures show no statistically significant influence on firm performance during the study period.

4.4 Discussion of Results

The regression results in Table 3 show that Scope 1 carbon emission disclosure (SC1) has a positive but statistically insignificant relationship with both return on assets (ROA) and return on equity (ROE). This suggests that direct emissions disclosure does not significantly influence the financial performance of listed manufacturing firms in Nigeria. The finding contrasts with evidence from developed economies where carbon transparency improves legitimacy, stakeholder confidence, and operational performance (Matsumura et al., 2014; Gallego-Álvarez et al., 2015). However, it aligns with studies from emerging markets which argue that environmental disclosures may not generate immediate financial benefits where environmental enforcement and investor sensitivity remain weak (Ganda & Milondzo, 2018; Miah et al., 2021).

The result supports legitimacy theory, which explains that firms disclose environmental information to maintain societal acceptance and corporate legitimacy. However, the insignificant effect implies that such disclosures may not yet produce tangible economic benefits of institutional environment in Nigeria. Similarly, signaling theory suggests that disclosures only influence investors when they are perceived as credible and value relevant. Weak reporting standards and limited external assurance may therefore reduce the financial relevance of Scope 1 disclosure. In contrast, Scope 2 carbon emission disclosure (SC2) exhibits a negative and statistically significant relationship with both ROA and ROE. This indicates that energy related emissions disclosure is associated with lower financial performance among Nigerian manufacturing firms.

The finding is consistent with studies linking energy intensive operations and high utility costs to

reduced profitability (Alvarez, 2012; Houqe et al., 2022). It also reflects the realities of the Nigerian manufacturing sector, where firms face unstable electricity supply and depend heavily on costly alternative energy sources. The finding further supports legitimacy and stakeholder theories. While firms disclose Scope 2 emissions to satisfy stakeholder expectations and demonstrate environmental responsibility, such disclosures may simultaneously expose operational inefficiencies and energy-related vulnerabilities, thereby reducing profitability and investor confidence.

Finally, Scope 3 carbon emission disclosure (SC3) shows no statistically significant relationship with either ROA or ROE. This finding is consistent with prior studies emphasizing the complexity and limited reliability of value-chain emission disclosures, particularly in developing economies (Cucchiella et al., 2017; Zhang et al., 2023). The result also supports signaling theory, which argues that disclosures only influence stakeholders when they are reliable and verifiable. Since Scope 3 emissions are difficult to measure and monitor across supply chains, investors may discount their relevance in assessing firm performance. Overall, the findings suggest that the financial implications of carbon emission disclosure depend largely on institutional conditions, regulatory quality, and infrastructural realities within the Nigerian business environment.

5.0 Conclusion and Recommendation

This study was motivated by growing concerns about the environmental footprint of manufacturing activities and the increasing demand by investors, regulators, and other stakeholders for transparent carbon-related disclosures, particularly in emerging economies such as Nigeria. Despite the rising global emphasis on climate accountability, empirical evidence on whether carbon emission disclosures translate into improved firm-level financial outcomes in African capital markets remains limited and inconclusive. Against this backdrop, the study set out to examine the effect of carbon emission disclosure disaggregated into Scope 1 (direct emissions), Scope 2 (energy related indirect emissions), and Scope 3 (other indirect value-chain emissions) on the financial performance of listed manufacturing firms in Nigeria over the period 2015–2024.

To achieve this objective, the study employed a balanced panel of listed manufacturing firms and adopted a robust econometric approach. Financial performance was measured using return on assets (ROA) and return on equity (ROE), while carbon emission disclosure was captured using binary indicators for Scope 1, Scope 2, and Scope 3 disclosures. Firm size, earnings per share, and leverage were included as control variables to account for firm-specific characteristics. The analysis progressed from descriptive statistics and correlation analysis to multivariate regression estimations using Ordinary Least Squares (OLS), Fixed Effects (FE), and Random Effects (RE) models. Diagnostic tests, including heteroscedasticity, multicollinearity, and Hausman specification tests, were conducted to ensure the reliability and appropriateness of the estimated models.

The empirical findings reveal a nuanced relationship between carbon emission disclosure and financial performance. Specifically, Scope 1 and Scope 3 carbon emission disclosures exhibit positive but statistically insignificant associations with both ROA and ROE, suggesting that disclosures relating to direct emissions and value-chain emissions do not exert a measurable short-term impact on firm performance in the Nigerian manufacturing sector. In contrast, Scope 2 disclosure demonstrates a consistently negative and statistically significant relationship with financial performance, indicating that energy-related emission disclosures are associated with reduced profitability. This finding reflects the cost-intensive nature of energy consumption in Nigeria, where limited access to clean and affordable energy sources may cause higher operational costs to outweigh the reputational or legitimacy benefits of disclosure. Overall, the results suggest that while carbon disclosure practices are increasingly adopted, their financial consequences are highly context-dependent and shaped by institutional, infrastructural, and market conditions.

In conclusion, the study finds that carbon emission disclosure does not uniformly improve the financial performance of listed manufacturing firms in Nigeria. While Scope 1 and Scope 3 disclosures exert no significant influence on firm performance, Scope 2 disclosure significantly reduces profitability, reflecting the high energy costs and infrastructural challenges confronting manufacturing firms in the Nigerian business environment. The study therefore concludes that the financial consequences of

carbon emission disclosure are highly dependent on institutional conditions, energy efficiency, and the broader economic environment within which firms operate. Consequently, carbon disclosure in emerging markets should not be viewed merely as a symbolic sustainability exercise, but as a strategic activity whose financial outcomes depend on the extent to which firms possess the operational capacity and institutional support necessary to manage environmental responsibilities effectively.

The implications of these findings are multifaceted. For managers, the results highlight the need to complement carbon disclosure with substantive investments in energy efficiency, cleaner technologies, and operational restructuring, rather than treating disclosure as a symbolic compliance exercise. Policymakers and regulators are encouraged to strengthen environmental reporting frameworks and provide incentives such as tax reliefs, energy subsidies, or carbon markets that can help firms internalize environmental responsibility without compromising financial viability. For investors, the findings suggest that carbon disclosures in emerging markets should be interpreted cautiously, as not all emission-related disclosures currently signal superior financial performance. From an academic perspective, the study contributes to the carbon performance literature by providing Africa specific evidence and by disaggregating emissions into Scope-based measures, thereby enriching understanding of heterogeneous disclosure effects.

Notwithstanding its contributions, the study is subject to certain limitations. First, carbon emission disclosure was measured using binary indicators, which may not fully capture the intensity, quality, or credibility of the disclosures. Second, the analysis focused exclusively on listed manufacturing firms in Nigeria, limiting the generalizability of the findings to other sectors or institutional contexts. Third, the study examined financial performance using accounting-based measures, which may not fully reflect market-based valuation effects or long-term sustainability benefits of carbon management practices. Future research may address these limitations by incorporating quantitative emission intensity measures, disclosure quality indices, or third-party verified carbon data. Extending the analysis to other African countries or conducting cross-country comparative studies would further enhance external validity. In addition, future studies could explore moderating or mediating factors such as environmental regulation strength, energy efficiency investments, corporate governance mechanisms, or carbon pricing policies to better explain when and how carbon emission disclosure translates into improved firm performance. Such extensions would deepen insights into the evolving role of climate-related disclosures in shaping sustainable corporate outcomes in emerging markets.

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