

Carbon Accounting Practices and Financial Performance of Listed Oil and Gas Companies in Nigeria.

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ABSTRACT

The growing emphasis on environmental sustainability and climate change mitigation has heightened the need for firms to adopt effective carbon accounting practices. This study examined the effect of carbon accounting practices on the financial performance of listed oil and gas companies in Nigeria. Specifically, it investigated the influence of emission intensity, carbon reduction initiatives, and carbon cost accounting on financial performance measured by Return on Assets (ROA). An ex post facto research design was adopted using secondary data obtained from the annual and sustainability reports of five purposively selected oil and gas companies from the seven firms listed on the Nigerian Exchange Group (NGX) over the period 2014–2025. Data were analysed using descriptive statistics, correlation analysis, and panel regression techniques, with firm size included as a control variable. The findings revealed that emission intensity negatively affected financial performance ($\beta = -0.254$, $p = 0.034$), whereas carbon reduction initiatives exerted a positive and significant effect ($\beta = 2.271$, $p = 0.013$). Carbon cost accounting exhibited a negative but statistically insignificant effect ($\beta = -0.020$, $p = 0.098$), while firm size had a positive but insignificant relationship with ROA. The model explained 41.7% of the variation in financial performance ($R^2 = 0.417$). The study concludes that improving carbon efficiency and investing in carbon reduction initiatives can enhance corporate profitability, whereas carbon-related expenditures alone are insufficient to influence financial performance. These findings extend the carbon accounting literature within emerging economies and provide empirical support for the Resource-Based View theory by demonstrating that proactive carbon management can serve as a strategic capability for achieving sustainable financial performance.

Keywords: Carbon Accounting, Emission Intensity, Carbon Reduction Initiatives, Carbon Cost Accounting, Financial Performance, Return on Assets, Oil and Gas Companies, Nigeria.

JEL Classification Codes: M41, Q56, M14, L71.

INTRODUCTION

Climate change has emerged as one of the most significant environmental and economic challenges confronting businesses and governments worldwide. The increasing concentration of greenhouse gas (GHG) emissions in the atmosphere has intensified concerns about global warming, environmental degradation and the sustainability of economic activities (Kanna et al. 2024). In response, governments, regulators, investors, and international organisations have increased pressure on corporations to reduce their carbon footprint and adopt environmentally responsible business practices (Bocken and Allwood 2012). Consequently, carbon accounting has become an important component of corporate sustainability strategies, providing organisations with mechanisms for measuring, monitoring, reporting, and managing carbon emissions associated with their operations.

Globally, carbon accounting has gained prominence as countries pursue net-zero emission targets and implement climate-related regulatory frameworks (Di Vaio and Ali 2025). Developed economies such as the United Kingdom, the European Union member states, the United States, and Canada have strengthened environmental disclosure requirements and carbon management systems to enhance corporate accountability and climate resilience. As a result, firms are increasingly integrating carbon-related information into strategic decision-

making processes to improve environmental performance and maintain competitiveness in an increasingly sustainability-conscious business environment.

At the regional level, African countries face unique climate-related challenges despite contributing a relatively small proportion of global greenhouse gas emissions (Dal 2024). The continent remains highly vulnerable to the adverse effects of climate change, including desertification, flooding, biodiversity loss, food insecurity, and energy-related challenges. Consequently, governments and regulatory agencies across Africa have intensified efforts to promote environmental sustainability and climate governance. In sectors such as mining, manufacturing, and oil and gas, firms are increasingly encouraged to adopt carbon management practices and improve environmental reporting. However, the implementation of carbon accounting across many African economies remains relatively limited due to institutional constraints, weak regulatory enforcement, inadequate environmental reporting frameworks, and limited stakeholder pressure compared to developed economies.

Within Nigeria, environmental sustainability has become increasingly important due to the country's dependence on the oil and gas sector, which remains one of the largest contributors to greenhouse gas emissions and environmental degradation. Activities such as gas flaring, crude oil exploration, refining operations, and energy-intensive production processes continue to generate significant carbon emissions despite increasing regulatory attention. Although initiatives such as the Petroleum Industry Act (PIA) 2021 and various environmental reporting frameworks have sought to improve environmental accountability, concerns persist regarding the effectiveness of carbon management practices and their implications for corporate performance.

Carbon accounting extends beyond environmental disclosure and encompasses a broad range of practices designed to integrate carbon-related considerations into managerial decision-making and organisational performance evaluation (Johnson et al., 2025). These practices include the measurement of emission intensity, implementation of carbon reduction initiatives, and recognition of carbon-related costs within accounting systems. Through these mechanisms, firms are expected to improve environmental performance while simultaneously enhancing operational efficiency and long-term financial sustainability. As climate-related risks continue to gain prominence, carbon accounting has increasingly been viewed not only as an environmental management tool but also as a strategic instrument capable of influencing corporate financial performance.

The relationship between carbon accounting and financial performance has attracted considerable scholarly attention in recent years. However, empirical findings remain inconclusive. Some studies argue that carbon-intensive operations reduce profitability due to higher compliance costs, environmental liabilities, reputational risks, and resource inefficiencies (Ganda & Milondzo, 2018; Desai et al., 2022). Other studies suggest that firms with higher emissions may still achieve superior short-term financial performance because emissions often accompany increased production capacity and revenue generation, particularly in developing economies where environmental regulations are relatively weak (Vaicondam et al., 2024). Similarly, evidence regarding carbon reduction initiatives and carbon cost accounting remains mixed. While several studies report that proactive environmental initiatives enhance firm performance through efficiency gains and improved stakeholder relations (Issa, 2024), others find limited or insignificant financial benefits, particularly in contexts where environmental costs are not fully internalised (Nengzih, 2022).

These inconsistencies are particularly evident in developing economies, where institutional environments, regulatory enforcement, and stakeholder expectations differ substantially from those in developed countries.

Statement Of The Problem

Financial performance remains a major concern for listed oil and gas companies in Nigeria due to the volatile nature of the industry and increasing environmental sustainability obligations (Oyedokun and Erinoso 2022). Although the sector remains a key contributor to Nigeria's export earnings and government revenue, firms continue to face profitability challenges arising from fluctuations in global crude oil prices, exchange rate instability, production disruptions, and rising environmental compliance costs (Nweze and Edame 2016). Furthermore, Nigeria remains one of the world's leading gas-flaring countries, resulting in growing regulatory and stakeholder pressure on firms to invest in carbon emission reduction and environmental management

initiatives. While these investments are expected to improve environmental performance, their implications for financial performance remain uncertain, creating a practical challenge for managers, investors, and policymakers seeking to balance sustainability objectives with profitability.

Empirical evidence on the relationship between carbon accounting practices and financial performance remains inconclusive. Studies such as Ganda and Milondzo (2018), Desai et al. (2022), Issa (2024) and Nwokeogu et al. (2024) reported significant relationships between carbon-related practices and firm performance, whereas Nengzih (2022) found insignificant effects. In addition, most previous studies focused on carbon disclosure, sustainability reporting, or broad environmental management practices, with limited attention given to specific carbon accounting dimensions such as emission intensity, carbon reduction initiatives, and carbon cost accounting. Evidence from Nigeria, particularly within the oil and gas sector, also remains limited.

Motivated by these gaps and inconsistencies, this study examines the effect of carbon accounting practices on the financial performance of listed oil and gas companies in Nigeria. Specifically, the study investigates the influence of emission intensity, carbon reduction initiatives and carbon cost accounting on Return on Assets (ROA).

The study contributes to the growing literature on carbon accounting and corporate sustainability in several ways. First, it provides empirical evidence from the Nigerian oil and gas sector, an industry that remains underrepresented in the carbon accounting literature despite its environmental significance. Second, it shifts the focus from carbon disclosure to operational carbon accounting practices, thereby providing deeper insights into the mechanisms through which environmental management influences firm performance. Third, by disaggregating carbon accounting into emission intensity, carbon reduction initiatives and carbon cost accounting, the study offers a more critical understanding of the dimensions of carbon management that matter most for financial performance. The study seeks to provide empirical evidence that will assist corporate managers, investors, regulators, and policymakers in understanding the financial implications of carbon accounting practices and designing strategies that promote both environmental sustainability and improved financial performance..

Conceptual Review

Carbon Accounting

Carbon accounting has emerged as a critical component of environmental management and corporate sustainability in response to growing concerns about climate change and greenhouse gas (GHG) emissions. The concept broadly refers to the process of identifying, measuring, recording, reporting, and managing carbon emissions and carbon-related activities associated with organisational operations (Bui and De Villiers 2017). It provides firms with information necessary for monitoring environmental performance, complying with regulatory requirements, and supporting strategic decision-making aimed at reducing environmental impacts.

Ratnatunga and Balachandran (2009) define carbon accounting as a system that measures and manages the costs, risks, and opportunities associated with carbon emissions and climate change. According to the authors, carbon accounting extends traditional management accounting by incorporating carbon-related information into strategic planning, cost management, and performance evaluation. Similarly, Hazaea et al. (2023) describe carbon accounting as an environmental management mechanism that facilitates the collection and analysis of carbon-related information for internal decision-making and external reporting purposes.

Ong et al. (2021) view carbon accounting as a managerial tool that enables organisations to quantify and monitor carbon emissions while supporting the implementation of carbon governance structures and environmental strategies. Likewise, Syam et al. (2024) describe carbon accounting as a new accounting paradigm that integrates environmental considerations into accounting systems through the measurement and management of carbon emissions and related costs. The authors argue that carbon accounting represents a shift from conventional financial reporting towards a more sustainability-oriented accounting framework capable of supporting corporate environmental responsibility.

From a broader sustainability perspective, carbon accounting provides firms with mechanisms for evaluating the environmental consequences of their activities and integrating climate-related considerations into business operations (Rana et al., 2025). It serves as an important link between environmental management and corporate performance by enabling organisations to identify inefficiencies, monitor environmental risks, and implement mitigation strategies. Consequently, carbon accounting has become increasingly important for firms operating in environmentally sensitive industries such as oil and gas, manufacturing, transportation, and energy production.

Although carbon accounting has been conceptualised differently across the literature, a common theme is its role in facilitating environmental accountability and supporting sustainable business practices. The present study conceptualises carbon accounting as the systematic identification, measurement, monitoring, and management of carbon emissions and carbon-related activities undertaken by firms to improve environmental and financial performance. Specifically, the study operationalises carbon accounting through three dimensions: emission intensity, carbon reduction initiatives, and carbon cost accounting.

Emission Intensity

The Intergovernmental Panel on Climate Change (IPCC) considers emission intensity as a key indicator for assessing the environmental efficiency of economic activities and industrial processes. Similarly, Ganda and Milondzo (2018) define emission intensity as the volume of carbon emissions produced relative to organisational activities and argue that it provides a more meaningful assessment of environmental performance than absolute emission levels. Kumar and Firoz (2018) also conceptualise carbon intensity as the amount of carbon emissions generated per unit of business output, reflecting the efficiency with which firms utilise environmental resources.

Desai et al. (2022) view emission intensity as a measure of environmental efficiency that captures the relationship between carbon emissions and economic performance. According to the authors, lower emission intensity reflects more sustainable production processes and improved environmental management practices. Vaicondam et al. (2024) similarly describe emission intensity as an important environmental performance indicator used by investors, regulators, and stakeholders to evaluate corporate sustainability performance.

High emission intensity often indicates inefficient production processes, excessive energy consumption, reliance on carbon-intensive technologies, and weak environmental management practices (Chen and Wu 2022). Such conditions may expose firms to regulatory sanctions, reputational risks, environmental liabilities, and stakeholder pressure. Conversely, lower emission intensity reflects greater carbon efficiency and improved environmental performance, which may contribute to enhanced operational efficiency and long-term competitiveness (Zameer et al 2021).

In this study, emission intensity is conceptualised as the ratio of greenhouse gas emissions to firm revenue, representing the extent to which carbon emissions are generated relative to economic output. It serves as a proxy for carbon efficiency and environmental performance.

Carbon Reduction Initiatives

Carbon reduction initiatives refer to deliberate organisational actions aimed at reducing greenhouse gas emissions and improving environmental sustainability (Issa and In'airat 2024). These initiatives may include investments in energy-efficient technologies, renewable energy adoption, carbon capture systems, gas flare reduction programmes, process optimisation, waste minimisation strategies, and other environmental improvement projects.

Issa (2024) defines carbon reduction initiatives as organisational programmes designed to lower carbon emissions through strategic environmental investments and operational improvements. According to the author, such initiatives contribute to environmental sustainability while simultaneously enhancing organisational performance through efficiency gains and innovation. Similarly, Issa and In'airat (2024) describe carbon reduction initiatives as proactive environmental strategies aimed at mitigating climate change impacts and improving carbon performance.

Bui et al. (2022) argue that carbon reduction initiatives represent important components of corporate environmental strategies because they facilitate carbon savings and emissions reductions. Ong et al. (2021) further contend that carbon reduction initiatives reflect management's commitment to environmental responsibility and sustainable business practices. These initiatives are often associated with improved stakeholder relations, enhanced corporate reputation, reduced regulatory risks, and increased operational efficiency.

The implementation of carbon reduction initiatives has become increasingly important as governments and regulatory agencies strengthen environmental standards and sustainability reporting requirements (Mia et al. 2021). Firms that successfully implement such initiatives may achieve competitive advantages through cost savings, innovation, and improved stakeholder confidence.

For the purpose of this study, carbon reduction initiatives are conceptualised as the number of identifiable carbon mitigation programmes and environmental sustainability projects implemented by a firm during a reporting period. These initiatives reflect management's commitment to reducing carbon emissions and improving environmental performance.

Carbon Cost Accounting

Carbon cost accounting refers to the identification, measurement, recording, allocation, and reporting of carbon-related costs incurred by organisations in the course of managing environmental impacts and complying with sustainability requirements (Rauf et al. 2026). It represents an important component of carbon accounting because it enables firms to incorporate environmental costs into managerial decision-making and performance evaluation.

Ratnatunga and Balachandran (2009) define carbon cost accounting as a management accounting system designed to capture and allocate costs associated with carbon emissions, climate change risks, environmental compliance, and sustainability initiatives. According to the authors, carbon cost accounting provides managers with information necessary for evaluating environmental investments and making strategic decisions regarding carbon management.

Tuesta et al. (2021) describe carbon cost accounting as an environmental management accounting practice that facilitates the integration of carbon-related costs into organisational planning and control systems. Syam et al. (2024) similarly view carbon cost accounting as a mechanism for managing environmental costs and supporting sustainable business operations. The authors argue that carbon cost accounting improves transparency regarding environmental expenditures and enhances organisational accountability.

Carbon cost accounting plays an important role in helping firms evaluate the economic consequences of environmental decisions. Through the identification and measurement of carbon-related expenditures, organisations are able to assess the financial implications of environmental strategies and determine the effectiveness of carbon management programmes (Marlowe and Clarke 2022).

In this study, carbon cost accounting is defined as the monetary value of carbon-related expenditures incurred by firms in implementing environmental management activities, emissions reduction programmes, environmental compliance measures, and sustainability initiatives.

Financial Performance

Financial performance represents one of the most widely studied concepts in accounting, finance and strategic management literature. It generally refers to the extent to which an organisation achieves its financial objectives through effective resource utilisation and efficient operational management (Ellinger et al 2002).

Awan et al (2015) define financial performance as the achievement of organisational financial goals reflected through profitability, growth, and market valuation indicators. Similarly, Mihaela et al (2022). describe financial performance as the measurable outcomes of organisational activities captured through financial indicators such

as profitability and growth. Richard et al. (2009) conceptualise financial performance as a firm's ability to generate desirable financial outcomes including profitability, efficiency, and shareholder value.

Brigham and Ehrhardt (2013) view financial performance as the capacity of a firm to generate profits and maximise shareholder wealth. Likewise, Penman (2013) describes financial performance as an assessment of profitability and the sustainability of earnings over time. These perspectives collectively suggest that financial performance reflects the effectiveness with which firms utilise resources to create economic value.

For this study, financial performance is conceptualised as the ability of listed oil and gas companies to generate profits from their asset base through efficient operational and managerial practices.

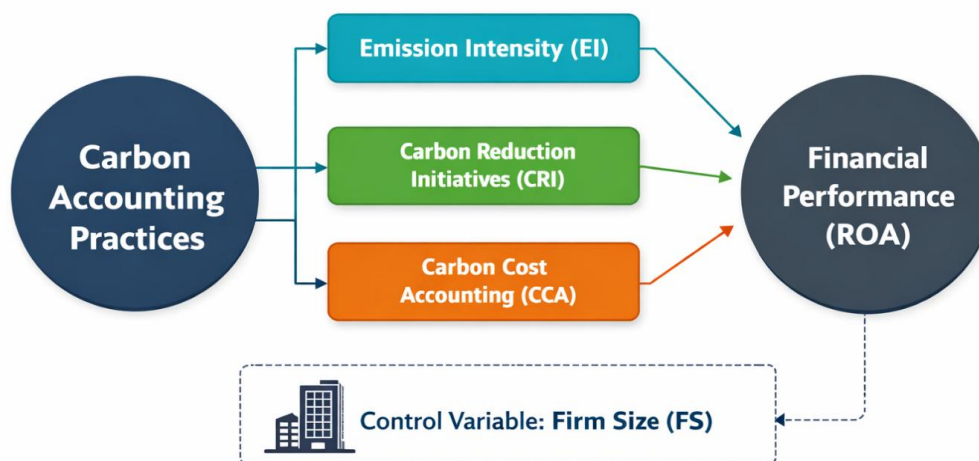
Return on Assets (ROA)

Return on Assets (ROA) is one of the most widely used accounting-based measures of financial performance. It evaluates the efficiency with which a firm utilises its total assets to generate earnings and is particularly relevant for asset-intensive industries such as oil and gas (Ndah et al 2025)

Nissim and Penman (2001) define ROA as a measure of the effectiveness with which a firm employs its assets to generate profits. Higgins (2009) similarly describes ROA as an indicator of the firm's ability to convert investments in assets into earnings. Gitman and Zutter (2012) define ROA as the ratio of net income to total assets and regard it as a comprehensive measure of managerial efficiency.

Brigham and Ehrhardt (2013) argue that ROA reflects how effectively management utilises organisational resources to create value. Richard et al. (2009) further identify ROA as an important indicator of operational efficiency and financial performance. Due to its direct link with asset utilisation and profitability, ROA is particularly suitable for evaluating the performance of firms operating in capital-intensive industries.

In this study, Return on Assets (ROA) is measured as profit after tax divided by total assets and serves as the proxy for financial performance



THEORETICAL REVIEW

Resource-Based View Theory

The Resource-Based View (RBV) theory, developed by Barney (1991), posits that firms achieve superior performance when they possess and effectively deploy resources and capabilities that are valuable, rare, inimitable, and non-substitutable. The theory argues that sustainable competitive advantage arises not merely from industry characteristics but from unique organisational resources and competencies that competitors cannot easily replicate. Such resources may include tangible assets, managerial expertise, technological capabilities, organisational processes, and strategic knowledge.

Hart (1995) extended the RBV through the Natural Resource-Based View (NRBV), which incorporates environmental sustainability into the resource-based framework. According to Hart, environmental capabilities such as pollution prevention, environmental innovation, and sustainable development can serve as strategic resources that generate long-term competitive advantage. Consequently, firms that effectively manage environmental risks and integrate sustainability practices into their operations are better positioned to improve efficiency, reduce waste, minimise regulatory risks, and enhance financial performance.

Within the context of carbon accounting, practices such as emission management, carbon reduction initiatives, and carbon cost accounting represent organisational capabilities that facilitate efficient resource utilisation and environmental performance improvement. By enabling firms to monitor emissions, reduce carbon-related inefficiencies, and make informed environmental decisions, these practices may contribute to enhanced profitability and long-term competitiveness.

Stakeholder Theory

Stakeholder Theory was popularised by Freeman (1984), who argued that organisations operate within a network of relationships involving various stakeholders, including shareholders, employees, customers, regulators, host communities, suppliers, and society at large. The theory maintains that organisational success depends on a firm's ability to recognise and balance the interests of these stakeholders rather than focusing solely on shareholder wealth maximisation.

In the context of environmental sustainability, stakeholders increasingly demand greater corporate accountability regarding carbon emissions, climate change mitigation, and environmental stewardship. Investors are paying greater attention to environmental performance indicators, regulators are strengthening environmental compliance requirements, while host communities and civil society groups increasingly scrutinise corporate environmental behaviour. Consequently, firms may adopt carbon accounting practices to respond to stakeholder expectations, maintain stakeholder confidence, and secure continued access to critical resources and support.

The theory suggests that effective carbon management and transparent environmental reporting can strengthen stakeholder relationships, enhance corporate reputation, and ultimately contribute to improved organisational performance. Therefore, carbon accounting practices may be viewed as strategic responses to stakeholder pressures and expectations.

Legitimacy Theory

Legitimacy Theory is based on the premise that organisations continually seek to ensure that their activities are perceived as legitimate and consistent with societal norms, values, and expectations (Suchman, 1995). The theory posits that firms operate under a social contract and must demonstrate socially acceptable behaviour to secure continued support and acceptance from society.

Environmental issues have become increasingly important determinants of corporate legitimacy. As public awareness of climate change and environmental sustainability grows, organisations face mounting pressure to demonstrate responsible environmental behaviour. Carbon accounting practices, sustainability reporting, and environmental disclosures therefore serve as mechanisms through which firms communicate their commitment to environmental stewardship and maintain societal legitimacy.

According to Legitimacy Theory, firms are more likely to adopt carbon management practices and disclose environmental information when societal expectations regarding environmental responsibility increase. Through such actions, organisations seek to reduce legitimacy gaps, improve public perception, and minimise reputational risks associated with environmentally harmful activities. This perspective is particularly relevant to the oil and gas sector, where environmental concerns frequently attract public scrutiny and regulatory attention.

Theoretical Framework of the Study

Although the Resource-Based View, Stakeholder Theory, and Legitimacy Theory each provide valuable insights into the relationship between carbon accounting practices and financial performance, the Resource-Based View

serves as the anchor theory for this study. Stakeholder Theory and Legitimacy Theory primarily explain the external pressures that motivate firms to adopt environmental and carbon management practices. They focus on how stakeholder expectations and societal demands influence organisational behaviour and environmental disclosures.

Empirical Review

Empirical evidence on the relationship between carbon accounting practices and financial performance remains inconclusive. Existing studies have reported positive, negative and insignificant relationships, suggesting that the financial consequences of carbon management are influenced by industry characteristics, institutional environments, and measurement approaches.

Studies examining emission intensity generally report adverse financial effects. Kumar and Firoz (2018) found that carbon emission intensity significantly reduced Return on Net Worth and Earnings per Share among Indian firms, suggesting that environmentally inefficient operations undermine profitability. Similarly, Ganda and Milondzo (2018) reported a significant negative relationship between carbon emissions and financial performance among South African firms, concluding that investments aimed at reducing emissions contribute to both environmental and financial performance. Desai et al. (2022) reinforced this position by documenting a significant negative effect of carbon emissions on both accounting-based and market-based measures of performance among Indian companies. These studies collectively support the argument that excessive emissions increase environmental risks, compliance costs, and operational inefficiencies, thereby reducing firm performance.

However, evidence from other jurisdictions suggests that the relationship may not be universally negative. Elago et al. (2025) found only a weak relationship between greenhouse gas emission intensity and Return on Assets among ASEAN firms, while the effect on market valuation was insignificant. The authors attributed this outcome to differences in regulatory enforcement and investor priorities across countries. The contrasting findings indicate that the financial implications of emission intensity remain highly context-dependent, particularly in emerging economies where environmental regulations are still evolving.

Research on carbon reduction initiatives presents relatively more consistent evidence. Issa (2024) found that carbon reduction initiatives positively influence financial performance among UK firms, arguing that environmental investments enhance operational efficiency and create long-term value. Similarly, Issa and In'airat (2024) reported that sustainability initiatives significantly reduce carbon emission intensity, implying that proactive environmental strategies contribute to improved environmental and organisational outcomes. These findings are consistent with the Resource-Based View, which suggests that environmental capabilities can serve as strategic resources that enhance competitiveness and profitability.

The evidence regarding carbon accounting systems and carbon-related costs remains less conclusive. Tuesta et al. (2021) found that carbon management accounting positively influences financial performance by improving environmental control systems and managerial decision-making. Likewise, Bui et al. (2022) demonstrated that high-quality carbon accounting systems strengthen the relationship between carbon strategy and carbon performance. In contrast, Nengzih (2022) found that environmental costs and carbon emission intensity do not significantly influence financial performance in the short run, suggesting that the benefits of environmental investments may materialise only over longer periods.

Within the Nigerian context, existing studies have focused largely on carbon disclosure rather than operational carbon accounting practices. Emmanuel et al. (2023) found that Scope 3 emission disclosure positively influences Return on Equity and Return on Sales among quoted financial service firms, while Yahaya (2026) reported that carbon disclosure quality significantly enhances both Return on Assets and Tobin's Q among listed non-financial firms. Similarly, Njoku and Worimegbe (2023) documented significant differences in financial performance between firms with higher and lower levels of carbon disclosure. In the oil and gas sector, Nwokeogu et al. (2024) found that carbon management practices positively and significantly influence Return on Assets. While these studies provide important evidence regarding environmental reporting and carbon

management, they offer limited insight into how specific operational carbon accounting practices influence financial performance.

The foregoing review reveals three important gaps. First, most existing studies focus on carbon disclosure, ESG performance, or sustainability reporting rather than operational carbon accounting practices. Second, empirical evidence from Nigeria remains scarce despite the environmental significance of its oil and gas sector. Third, limited attention has been given to the combined effects of emission intensity, carbon reduction initiatives, and carbon cost accounting on financial performance. This study addresses these gaps by examining the influence of these carbon accounting dimensions on the financial performance of listed oil and gas companies in Nigeria between 2014 and 2025.

METHODOLOGY

Research Design

This study employed an ex post facto research design. The design was considered appropriate because the study relied on historical data obtained from published corporate reports, and the researcher had no control over the variables under investigation. The design has been widely adopted in accounting and finance research involving the examination of relationships among variables using existing data.

Population and Sample

The population of this study comprised the seven (7) oil and gas companies listed on the Nigerian Exchange Group (NGX) as at 31 December 2025. Using purposive (criterion) sampling, five (5) companies were selected based on the availability, completeness, and consistency of their financial and carbon-related disclosures throughout the study period. The selected companies were Seplat Energy Plc, Oando Plc, Conoil Plc, Eterna Plc, and TotalEnergies Marketing Nigeria Plc. The exclusion of the remaining two companies was due to incomplete or inconsistent data, which could have compromised the reliability of the panel analysis. The study covered a twelve-year period from 2014 to 2025, resulting in a balanced panel dataset of 60 firm-year observations.

Data Sources and Measurement of Variables

The study relied exclusively on secondary data obtained from the annual reports, sustainability reports, and environmental disclosures of the selected companies. Financial data were extracted from the audited financial statements, while carbon-related information was obtained from sustainability and environmental reporting sections.

Financial performance was measured using Return on Assets (ROA), calculated as profit after tax divided by total assets. Carbon accounting practices were proxied by Emission Intensity (EI), Carbon Reduction Initiatives (CRI), and Carbon Cost Accounting (CCA). Firm Size (FS), measured as the natural logarithm of total assets, was included as a control variable.

Table 3.1: Variable Definition and Measurement

Variable Type	Variable Name	Symbol	Operational Measurement	Source	Justification
Dependent	Return on Assets	ROA	Net Profit After Tax/ Total Assets	Financial Statements	Le, H., et al. (2024).
Independent	Emission Intensity	EI	Total Scope 1 and Scope 2 GHG emissions / Total Revenue(₦ million)	Sustainability Reports / Gas Flare Trackers	Vaicondam et al 2024; Nengzih 2022
Independent	Carbon Reduction Initiatives	CRI	Number of distinct carbon reduction initiatives implemented and	Directors' Report / ESG Disclosures	Issa (2024); Issa and in'airat 2024

			disclosed by a firm in a given financial year		
Independent	Carbon cost Accounting	CCA	Total Environmental Provisions + Gas Flaring Penalties	Notes to the Financial Statements	Syam et al (2024); Bui et al (2023)
Control	Firm Size	FS	Log of Total Assets	Financial Statements	Kantudu and Samaila, (2015)

Model Specification

To examine the effect of carbon accounting practices on financial performance, the study adapted the Resource-Based View framework and specified the following panel regression model:

$$ROA_{it} = \beta_0 + \beta_1 EI_{it} + \beta_2 CRI_{it} + \beta_3 CCA_{it} + \beta_4 FS_{it} + u_{it}$$

Where:

- (ROA = Return on Assets
- (EI) = Emission Intensity
- (CRI) = Carbon Reduction Initiatives
- (CCA) = Carbon Cost Accounting
- (FS) = Firm Size
- β_0 = Intercept
- β_1 – β_4 = Regression coefficients
- u_{it} = Error term
- i = Firm
- t = Time period

Estimation Technique

Data were analysed using descriptive and inferential statistics. Descriptive statistics were used to summarise the characteristics of the variables, while correlation analysis was employed to examine the degree of association among the study variables. The hypotheses were tested using panel regression analysis because the dataset combines both cross-sectional and time-series observations. The panel regression approach controls for unobserved firm-specific heterogeneity and provides more efficient estimates than conventional cross-sectional or time-series techniques (Baltagi, 2008; Gujarati & Porter, 2009; Wooldridge, 2010). Statistical analyses were performed at a 5 percent level of significance.

FINDINGS

Descriptive Statistics

Table 4.1 presents the descriptive statistics of the study variables used in examining the effect of carbon accounting practices on the financial performance of listed oil and gas companies in Nigeria from 2014 to 2025.

Table 4.1: Descriptive Statistics of the Study Variables

Variable	EI	CRI	CCA	FS	ROA
N	60	60	60	60	60
Missing	0	0	0	0	0
Mean	65.3	2.48	333	7.50	69.8
Median	65.0	2.00	324	7.80	69.2
Std. Dev.	8.70	1.16	81.1	0.902	7.75
Minimum	48.5	1	196	6.11	56.1
Maximum	81.6	5	502	8.87	88.2
Skewness	-0.137	0.314	0.269	-0.181	0.647
Std. error skewness	0.309	0.309	0.309	0.309	0.309
Kurtosis	-1.04	-0.924	-0.888	-1.37	0.00823
Std. error kurtosis	0.608	0.608	0.608	0.608	0.608
Shapiro-Wilk W	0.961	0.891	0.965	0.907	0.954
Shapiro-Wilk p	0.055	<.001	0.083	<.001	0.024

Source: Jamovi software output 2026

Table 4.1 presents the descriptive statistics for the study variables. All variables comprise 60 balanced panel observations with no missing values, indicating complete data availability throughout the study period. Emission Intensity (EI) exhibits noticeable variability, reflecting differences in carbon efficiency across the sampled firms. Carbon Reduction Initiatives (CRI) averaged approximately two to three initiatives per firm-year, suggesting moderate adoption of carbon mitigation programmes. Carbon Cost Accounting (CCA) also displays considerable variation, indicating differences in environmental expenditures across firms, while Firm Size (FS) shows relatively low dispersion, suggesting broadly comparable firm sizes within the sample. Return on Assets (ROA) exhibits sufficient variation in financial performance across firms and years. Overall, the descriptive statistics indicate adequate variability in the study variables, providing a suitable basis for subsequent panel regression analysis.

Correlation Analysis

Correlation analysis was conducted to examine the direction and strength of the relationships among the study variables. The results are presented in Table 4.2.

Table 4.2: Correlation Matrix						
		EI	CRI	CC	FS	ROA
EI	Pearson's r	—				
	p-value	—				
CRI	Pearson's r	0.112	—			
	p-value	0.392	—			
CC	Pearson's r	0.512	0.163	—		
	p-value	<.001	0.214	—		
FS	Pearson's r	-0.252	0.568	0.031	—	
	p-value	0.052	<.001	0.817	—	
ROA	Pearson's r	-0.385	0.503	0.412	0.300	—
	p-value	0.002	<.001	0.001	0.020	—

Source : Jamovi software output 2026

Table 4.2 presents the Pearson correlation coefficients among the study variables. The results show that Emission Intensity (EI) is negatively and significantly associated with Return on Assets (ROA) ($r = -0.385$, $p = 0.002$), indicating that firms with higher emission intensity tend to exhibit lower financial performance. In contrast,

Carbon Reduction Initiatives (CRI) demonstrate a positive and significant relationship with ROA ($r = 0.503$, $p < 0.001$), suggesting that firms implementing more carbon reduction initiatives are associated with improved financial performance. Carbon Cost Accounting (CCA) and Firm Size (FS) are also positively and significantly correlated with ROA. Among the explanatory variables, the strongest correlation is observed between Carbon Reduction Initiatives and Firm Size ($r = 0.568$), followed by Emission Intensity and Carbon Cost Accounting ($r = 0.512$). The results indicate that multicollinearity is unlikely to be a serious concern, a conclusion further examined using the Variance Inflation Factor (VIF).

Variance Inflation Factor (VIF)

To assess the presence of multicollinearity among the explanatory variables, the Variance Inflation Factor (VIF) and tolerance statistics were computed. The results are presented in Table 4.3.

Table 4.3: Variance Inflation Factor (VIF) Results

Variable	VIF	Tolerance
EI	1.62	0.616
CRI	1.65	0.607
CCA	1.41	0.710
FS	1.78	0.563

Source: Jamovi software output 2026

The VIF values range from 1.41 to 1.78, while the corresponding tolerance values range from 0.563 to 0.710. All VIF values are below the commonly accepted threshold of 5.0, and all tolerance values exceed the minimum acceptable value of 0.10. These results indicate that multicollinearity is not a concern among the explanatory variables. Consequently, the independent variables are considered sufficiently distinct to permit reliable estimation of the regression coefficients, suggesting that the regression model is unlikely to suffer from coefficient instability arising from multicollinearity.

Heteroskedasticity Test

The heteroskedasticity test was conducted to determine whether the variance of the residuals remains constant across observations. The results are presented in Table 4.4.

Table 4.4: Heteroskedasticity Test Results

Test	Statistic	p-value
Breusch–Pagan	9.17	0.057
Goldfeld–Quandt	1.68	0.101
Harrison–McCabe	0.371	0.060

Source: Jamovi software output 2026

As presented in Table 4.4, the p-values associated with the Breusch–Pagan, Goldfeld–Quandt, and Harrison–McCabe tests all exceed the 5% significance level. Accordingly, the null hypothesis of homoskedasticity cannot be rejected, indicating that the variance of the regression residuals is constant across observations. This suggests that heteroskedasticity is not a concern in the estimated model and supports the reliability and efficiency of the regression estimates.

Hausman Specification Test

The Hausman specification test was employed to determine the most appropriate panel estimation technique between the fixed effects and random effects models.

Table 4.5: Hausman Test Results

Test Summary	Chi-Square	df	p-value
Cross-section Random	5.87234	4	0.209

Source: Jamovi software output 2026

As shown in Table 4.5, the Hausman test produced a probability value greater than the 5% significance level. Accordingly, the null hypothesis was not rejected, indicating that the random effects estimator is more appropriate than the fixed effects estimator. Consequently, the random effects model was adopted for estimating the relationship between carbon accounting practices and the financial performance of the sampled oil and gas companies.

Regression Results

The regression analysis was conducted to determine the effect of carbon accounting practices on the financial performance of listed oil and gas companies in Nigeria.

Table 4.6: Model Fit Statistics

R	R ²	Adjusted R ²	F	df1	df2	p-value
0.645	0.417	0.374	9.82	4	55	<0.001

Source: Jamovi software output 2026

The regression model explains approximately 41.7% of the variation in the financial performance of the sampled firms ($R^2 = 0.417$), while the adjusted R^2 of 0.374 indicates that, after adjusting for the number of explanatory variables, the model retains substantial explanatory power. The F-statistic of 9.82 with a probability value of $p < 0.001$ confirms that the model is statistically significant, indicating that the explanatory variables jointly provide a meaningful explanation of variations in firms' financial performance.

Table 4.7: Regression Coefficients

Predictor	Coefficient	SE	t-value	p-value
Constant	29.9002	11.7401	2.55	0.014
EI	-0.2539	0.1169	-2.17	0.034
CRI	2.2706	0.8858	2.56	0.013
CCA	-0.0197	0.0117	-1.68	0.098
FS	1.4846	1.1797	1.26	0.214

Source: Jamovi software output 2026

The regression estimates indicate that Emission Intensity (EI) exerts a negative and statistically significant effect on financial performance ($\beta = -0.2539$, $p = 0.034$). This suggests that increases in emission intensity are associated with lower Return on Assets, implying that environmentally inefficient operations may reduce profitability through increased compliance costs, operational inefficiencies, or reputational risks. The finding supports the expectation that effective emission management contributes to improved financial performance.

Carbon Reduction Initiatives (CRI) exhibit a positive and statistically significant relationship with financial performance ($\beta = 2.2706$, $p = 0.013$). This indicates that firms implementing a greater number of carbon reduction initiatives tend to achieve higher profitability, suggesting that proactive environmental management can generate operational efficiencies and strengthen long-term firm performance.

Although Carbon Cost Accounting (CCA) records a negative coefficient ($\beta = -0.0197$), the relationship is not statistically significant ($p = 0.098$). This indicates that the evidence is insufficient to conclude that carbon-related

expenditures have a measurable influence on the financial performance of the sampled firms during the study period. Similarly, Firm Size (FS) has a positive but statistically insignificant coefficient ($\beta = 1.4846$, $p = 0.214$), suggesting that differences in firm size do not significantly explain variations in Return on Assets after controlling for carbon accounting practices.

Overall, the regression results demonstrate that carbon accounting practices have important implications for the financial performance of listed oil and gas companies in Nigeria. Specifically, reducing emission intensity and increasing carbon reduction initiatives are associated with improved profitability, whereas carbon-related expenditures and firm size do not exhibit statistically significant effects within the estimated model. These findings underscore the importance of proactive carbon management as a strategic approach to enhancing both environmental sustainability and corporate financial performance.

Test Of Hypotheses

The hypotheses were tested using the regression results at a 5% significance level ($\alpha = 0.05$). The decision rule is to reject the null hypothesis when the p-value is less than 0.05, and fail to reject it otherwise.

H₀₁: Emission intensity has no significant effect on financial performance

Carbon emission intensity (EI) is statistically significant ($\beta = -0.2539$, $p = 0.034$). Since $p < 0.05$, the null hypothesis is **rejected**. This implies that emission intensity has a significant negative effect on financial performance.

H₀₂: Carbon reduction initiatives have no significant effect on financial performance

Carbon reduction initiatives (CRI) are statistically significant ($\beta = 2.2706$, $p = 0.013$). Since $p < 0.05$, the null hypothesis is **rejected**. This indicates that carbon reduction initiatives have a significant positive effect on financial performance.

H₀₃: Carbon cost Accounting has no significant effect on financial performance

Carbon cost Accounting (CCA) is not statistically significant ($\beta = -0.0197$, $p = 0.098$). Since $p > 0.05$, the null hypothesis is not rejected. This suggests that Carbon cost Accounting does not have a significant effect on financial performance.

DISCUSSION OF FINDINGS

Emission Intensity and Financial Performance

The empirical results reveal that emission intensity has a significant negative effect on the financial performance of listed oil and gas companies in Nigeria. This suggests that firms with higher carbon emissions are more likely to experience lower profitability, possibly due to increased environmental compliance costs, operational inefficiencies, and reputational risks associated with carbon-intensive operations. This finding is consistent with Ganda and Milondzo (2018), Kumar and Firoz (2018), and Desai et al. (2022), who reported that higher emission intensity adversely affects firm performance, but contrasts with Elago et al. (2025), who found only a weak relationship. The result supports the Resource-Based View (RBV), which posits that efficient environmental resource management constitutes a strategic capability capable of enhancing organisational performance.

Carbon Reduction Initiatives and Financial Performance

Evidence from the regression analysis indicates that carbon reduction initiatives exert a positive and significant influence on financial performance. This implies that firms undertaking more carbon reduction initiatives are likely to achieve superior profitability through improved operational efficiency, lower environmental risks, and stronger stakeholder confidence. The finding corroborates Issa (2024) and Issa and In'airat (2024), who reported that proactive environmental initiatives improve organisational performance, although it differs from studies that

found limited short-term financial benefits from environmental investments. The result is consistent with the Resource-Based View, which recognises environmental innovation and sustainability initiatives as strategic capabilities capable of generating competitive advantage.

Carbon Cost Accounting and Financial Performance

The regression estimates show that carbon cost accounting has a negative but statistically insignificant effect on financial performance. This indicates that carbon-related expenditures alone do not significantly influence profitability within the study period, possibly because the financial benefits of environmental investments are realised over a longer horizon. The finding agrees with Nengzih (2022), who reported an insignificant relationship between environmental costs and financial performance, but differs from Tuesta et al. (2021), who found that carbon management accounting contributes positively to organisational performance. From the perspective of the Resource-Based View, carbon-related expenditures create value only when they are effectively integrated into organisational strategy and operational decision-making.

Firm Size and Financial Performance

The findings further indicate that firm size has a positive but statistically insignificant effect on financial performance. This suggests that larger firms do not necessarily achieve superior profitability after controlling for carbon accounting practices. Although larger organisations often possess greater financial and technological resources, these advantages may not translate into improved performance unless they are efficiently deployed. This finding is consistent with the Resource-Based View, which emphasises that sustainable competitive advantage depends on the effective utilisation of organisational resources rather than their mere possession.

CONCLUSION AND RECOMMENDATIONS

This study examined the effect of carbon accounting practices on the financial performance of listed oil and gas companies in Nigeria over the period 2014–2025. Specifically, it investigated the effects of emission intensity, carbon reduction initiatives, and carbon cost accounting on financial performance, measured by Return on Assets (ROA), while controlling for firm size. The findings demonstrate that carbon accounting practices are important determinants of corporate financial performance, although their effects vary across different dimensions of carbon management.

The results revealed that emission intensity exerts a significant negative effect on financial performance, indicating that firms with higher carbon emissions relative to their operational activities are more likely to experience lower profitability due to increased environmental risks, compliance costs, and operational inefficiencies. Conversely, carbon reduction initiatives were found to have a positive and statistically significant effect on financial performance, demonstrating that investments in cleaner technologies, energy efficiency, gas flare reduction, and other carbon mitigation strategies generate both environmental and economic benefits. Although carbon cost accounting exhibited a negative relationship with financial performance, its effect was statistically insignificant, suggesting that carbon-related expenditures alone have not yet become a significant determinant of profitability within Nigeria's listed oil and gas sector.

Overall, the study concludes that carbon accounting should no longer be viewed merely as a regulatory compliance requirement but as a strategic management capability capable of enhancing both environmental sustainability and long-term corporate financial performance. By providing empirical evidence from Nigeria's oil and gas sector, the study extends the carbon accounting literature and reinforces the Resource-Based View by demonstrating that carbon efficiency and proactive carbon reduction initiatives constitute valuable organisational capabilities capable of creating sustainable competitive advantage.

Based on these findings, the study recommends that:

Oil and gas companies should intensify investments in carbon reduction initiatives, including gas flare recovery, energy efficiency improvements, methane emission control, renewable energy adoption, and process

optimisation. These initiatives should be prioritised because they simultaneously improve environmental sustainability and corporate financial performance.

Corporate management should prioritise carbon efficiency by implementing cleaner production technologies, improving operational processes, and promoting efficient resource utilisation. Reducing emission intensity will not only strengthen environmental performance but also enhance long-term profitability and organisational competitiveness.

Organisations should integrate carbon accounting into strategic planning and managerial decision-making rather than treating it solely as a regulatory compliance requirement. Carbon accounting information should be used to identify operational inefficiencies, evaluate environmental risks, support investment decisions and improve resource allocation.

Regulatory agencies, particularly the Nigerian Upstream Petroleum Regulatory Commission (NUPRC), the Nigerian Midstream and Downstream Petroleum Regulatory Authority (NMDPRA), and the Federal Ministry of Environment, should strengthen the monitoring and enforcement of environmental regulations to encourage greater corporate commitment to carbon efficiency and sustainable environmental practices.

The Financial Reporting Council of Nigeria (FRCN) and the Nigerian Exchange Group (NGX) should develop and enforce more comprehensive carbon accounting reporting guidelines. Standardised reporting frameworks will improve transparency, comparability, accountability, and the quality of environmental disclosures across the oil and gas industry.

Government should expand policy incentives that encourage environmental investments through green financing schemes, tax incentives, environmental grants, and accelerated capital allowances. Such incentives will encourage firms to invest in cleaner technologies and accelerate the transition towards low-carbon operations.

Environmental policy should progressively strengthen carbon cost internalisation through effective carbon pricing mechanisms, environmental levies, and emissions-related penalties. Strengthening these policy instruments will encourage firms to incorporate carbon costs into strategic decision-making and promote more sustainable business practices.

While this study provides important empirical evidence on the relationship between carbon accounting practices and financial performance, its findings should be interpreted within the context of certain limitations. The study focused exclusively on listed oil and gas companies in Nigeria and employed Return on Assets (ROA) as the measure of financial performance. Future research may extend the analysis by incorporating market-based performance measures, additional dimensions of carbon accounting, and comparative evidence from other industries and jurisdictions to provide broader insights into the financial implications of corporate carbon management. As environmental sustainability increasingly becomes central to corporate competitiveness, strengthening carbon accounting practices will be essential not only for regulatory compliance but also for enhancing long-term financial resilience and sustainable value creation.

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