

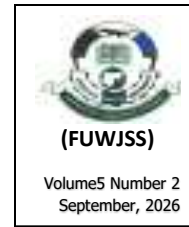
INFLUENCE OF GREEN ACCOUNTING AND FINANCIAL SUSTAINABILITY ON NIGERIAN OIL AND GAS FIRMS

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Abstract

This study examines the influence of green accounting on financial sustainability of Nigerian oil and gas firms, with corporate governance standing as a moderating role. The study relied on secondary data from the annual reports of seven purposively selected oil and gas firms listed on the Nigerian Exchange Group plc between 2015 and 2024. The collated data were analyzed using correlation analysis, descriptive analysis, random forest machine learning model and random effect regression alongside with some diagnostic tests. Findings discover a positive significant influence of green accounting; a positive significant influence of corporate governance; a positive significant influence of profitability; and a strongest positive significant joint influence of corporate governance and green accounting on financial sustainability, indicating that governance quality is a strong condition which amplifies the financial gains of green accounting practices. This study concludes that green accounting contributes positively to financial sustainability of Nigerian oil and gas firms. This study informs the oil and gas stakeholders that earnings is matter because a financially profitable firm is better positioned to maintain sustainability, but other environmental and governance factors also play more significant roles in improving firms' sustainability. The study recommends that Nigerian and other emerging markets governments should design fiscal incentive packages like tax deductions to reward any firm that meet pre-defined governance quality and environmental expenditure thresholds to encourage firms pursue green accounting practice and transform to more sustainable operations.

Keywords: Corporate governance, financial sustainability, green accounting, oil and gas firms

Introduction

Nature and the surrounding ecology are receiving increasing attention as sustainable development gains global momentum. Environmental professionals are very concerned about the harm that human activity is causing to the environment necessitating migration from volume to efficiency of green expenditures to achieve sustainable financial outcomes (Khalid, 2025). Strengthening corporate governance structure and incorporate green accounting into corporate financial sustainability are essential growing demands for environmental protection and business survival (Wahyuni et al, 2019). While green accounting offers a framework for incorporating environmental spending and sustainability into corporate financial strategy as a means of aligning corporate operations with long-term goals environmental sustainability, the effective corporate governance ensures strict compliance with the environmental policy and regulations (Oyedokun et al., 2019). Green accounting is builds upon the traditional accounting systems by including sustainability metrics, resource consumption, and environmental costs into financial decision-making procedures (Ekubiat, 2020).

Many corporate organizations in Nigeria are still struggling to maintain environmental disclosure due to some challenges despite their countries' abundance natural resources in oil and gas products (Khalid, 2025). These challenges include poor infrastructure, lack of funding, ineffective governance structures and exposure to some unaccountable serious environmental disasters (Umaigba et al., 2025). Additionally, underlying financial effects of environmental problems like pollution, deforestation, and oil spills are frequently ignored by conventional accounting procedures as many companies continue to struggle with poor financial reporting system even with the acknowledgement of the importance of corporate governance (Reuters, 2025). Empirical evidence affirms that some corporate expenditure may have minimal immediate financial impact but with insignificant long-term benefits due to poor governance mechanisms (Adegboye & Oladipo, 2023).

Previous studies review like Zeileis et al. (2002); Adegbite and Salami (2023); Finance in Africa (2025) also indicated that institutional environments in developing countries differ significantly from those of developed markets limiting the empirical evidence. Besides, disparities in the formats of sustainability reporting make it more problematic to determine the financial sustainability initiatives of some companies and track their progress in emerging economies. Studies confirm that the evaluation of corporate financial sustainability initiatives is further complicated by the absence of standardized sustainability disclosure, which restricts the coverage of insightful evaluations (Olatunji & Kareem, 2025).

Furthermore, unlike prior research like those conducted by Emeka-Nwokeji (2019); Okonkwo et al. (2019); Emeka-Nwokeji and Okeke (2019); Wahyuni-Meutia and Syamsurijal (2019); Oyedokun et al. (2019); Okonkwo et al. (2019); Iliemena (2020); Yusuf and Ekubiat (2020); Gujarati and Porter (2021); Hellwig (2021); Keweloh et al. (2023); Mensah (2023); Okeke et al. (2023); Inokon and Umobong (2024); Ezeani and Okafor (2024); Oyeleke and Onatunji (2024); Bello (2024); Yusuf and Bello (2024); Onatunji (2024); Umaigba et al. (2025); Omooseti and Akinjobi (2025); Edward et al. (2025); Akinwale and Ogunleye (2025); Mutai et al. (2025); Agba et al. (2026) and a host of other researchers which investigated corporate governance, environmental performance and financial sustainability as independent variables in separate empirical frameworks, this research introduces corporate governance as a moderation model, indicating limited research on how corporate governance moderates the effect of green accounting on financial sustainability of Nigeria oil and gas firms.

Based on the above background and the identified gaps this study is motivated to investigate the effect of green accounting on financial sustainability of Nigerian oil and gas firms, with corporate governance standing as a moderating role. Specifically, the study evaluates the effect of environmental expenditure on financial sustainability of Nigerian oil and gas firms; assesses the moderating effect of board independence on financial sustainability of Nigerian oil and gas firms; analyzes whether corporate governance weakens or strengthens the effect of green accounting to financial sustainability of Nigerian oil and gas firms.

This study discovers that while earnings matter because a financially profitable firm is better positioned to maintain sustainability, however other environmental and governance factors also play more significant roles in improving firms' sustainability in Nigeria. The study informs the oil and gas stakeholders that green accounting practice is strongly conditioned by governance quality. This study differs from previous studies by operationalizing the variable of financial sustainability using Altman's Z-score that captures profitability, solvency, and liquidity dimensions of firms' corporate financial health, rather than depending on single-item of performance proxies. Additionally, the integration of panel econometrics with random forest machine learning represents an innovative methodological approach that offer a comprehensive analytical lens for investigating complex sustainability research.

Theoretical Framework

This research is pinned on the sustainability theory coined by the International Monetary Fund [IMF] (2002) to investigate the contribution of

green accounting on financial sustainability of Nigerian oil and gas firms, while corporate governance serves as a moderating role. The sustainability theory focuses on how to strike a balance between social, environmental, and economic goals to ensure long-term development (Inokon & Umobong, 2024). Financial sustainability is still a major problem facing corporate organizations in developing economies, particularly in resource-dependent countries like Nigeria (Khalid, 2025). The theory argues that determining a balance between efficient expenditure spending, profit generation, and leverage management is essential for sustainable corporate policy (Mensah, 2023). Growing corporate loss and persistent high financial leverage pose a threat to Nigeria's firms stability and corporate financial sustainability (Ironkwe & Success, 2017). Poor profitability, revenue generation and inflationary pressures exacerbate financial imbalances, making corporate sustainability an essential policy objective (Keweloh et al., 2023).

Sustainability theory therefore emphasizes the need for integrating social, economic, and environmental dimensions for corporate development (Mondal, 2018). Sustainable development frameworks are increasingly impacting corporate financial management systems, particularly through the application of green accounting (Mutai et al., 2025). The concept supports the assertion that environmental investments have long-term economic benefits despite short-term expenses (Nwankwo & Uche, 2024). The review above establishes that sustainability theory is relevant in the research as it emphasizes on how green accounting and corporate governance contribute to financial sustainability of firms.

Green Accounting, Corporate Governance and Financial Sustainability in Nigerian Oil and Gas

Green accounting is the methodical incorporation of environmental costs and benefits into financial reporting and policy analysis. It promotes sustainable resource management and increases transparency (Agba et al., 2026). Furthermore, the identification, quantification, and reporting of environmental costs and gains associated with economic activities are all part of green accounting (Emeka-Nwokeji, 2019). This enhances financial reporting transparency and accountability in both the public and commercial sectors. The practice of accounting for environmental costs, consequences, and results is called "green accounting," sometimes referred to as environmental accounting (Emeka-Nwokeji & Okeke, 2019). Green accounting facilitates more efficient resource allocation, promotes environmental responsibility, and aligns economic activity with sustainability goals by including environmental externalities into frameworks for fiscal sustainability (Gujarati & Porter, 2021). Its main goals

are to increase the stock of human capital and raise awareness of the costs associated with future pollution (Ezeani & Okafor, 2024).

Environmental spending are crucial tactics for achieving sustainable corporate finance (Edward et al., 2025). In emerging economies incorporating environmental factors into corporate budgeting gradually improves their financial discipline. Although they are increasingly rising as a result of better environmental governance and budgetary transparency, Green budget allocations remain very modest (Gujarati & Porter, 2021). In essence, green accounting is a new accounting paradigm that employs the accounting process (recognition, measurement of value, recording, summarizing, presenting and reporting, and disclosing information to concentrate on objects, transactions or social events, and environmental events (Hellwig, 2021).

Corporate governance is a systematic process of directing and controlling the activities of an organization in the best interest of its stakeholders (Omooseti & Akinjobi, 2025) (. Corporate governance entails CEO compensation, improved stakeholder involvement, sound business policies and incorporated sustainability (Smith & Maseko, 2022). Strong corporate governance promotes integrity and helps in creating inclusive and stable institutions (Zhu et al., 2020). Companies need to adopt sustainable governance practices that will have positive impact on customer behavior (Wajdi & Jarboui, 2023). Financial sustainability is a corporate ability to generate enough financial resources to maintain growth, meet its obligations, support its operations and create long-term value without jeopardizing future viability (Oyeleke & Onatunji, 2024). It is a firm ability to maintain acceptable earning risk profiles and long-term economic viability through effective risk management, stable growth and ensuring survival (Adegboye & Oladipo, 2023). The components of financial sustainability include but not limited to solvency sustainability, profitability sustainability, liquidity sustainability, risk sustainability and growth sustainability (Edward et al., 2025). However, unlike corporate financial performance, the focus of financial sustainability is on continuity and enduring economic health (Akinwale & Ogunleye, 2025). Thus, financial sustainability discloses the firms' capability to continuously generate economic value while ensuring effective management of risks that may serve as a roadblock to its future performance (Mutai et al., 2025).

An overview of earlier research shows how various empirical investigations on sustainability and green accounting have been carried out. For example, the impact of adopting green accounting on improving environmental performance in Indonesian mining and energy companies was studied by Wahyuni et al. (2019). The three-year period covered by this study was 2014–2016. The GRI-G4 report type was utilized to obtain

secondary data from sustainability reporting. The data analysis technique used was panel data regression with a random effect model approach. The results show that using green accounting in the form of recycled materials, renewable energy, and green cost allocation has a good and significant influence on improving environmental performance. However, the allocation of Corporate Social Responsibility (CSR) funding has no bearing on environmental performance.

Rahman and Uddin (2020), who their studies emphasized that corporate governance is fundamental to strong sustainable economies. The study found that the companies are yet to implement full governance frameworks and plans to address sustainable growth. This perception was reaffirmed in the study conducted by Smith and Maseko's (2022) on promoting sound corporate governance practices, through digital financial reporting tools was conducted in developing markets. The findings discovered that digital reporting tools are essential for upholding accountability and improving corporate governance performance. The study also discovered that using these digital tools is difficult in less developed economies.

Adegbite and Salami (2023) examined Sub-Saharan Africa's fiscal sustainability and environmental accounting. The study employed a quantitative study approach and panel data from international financial sources, such as the World Bank and IMF, covering the years 2005 to 2021. The study included econometric methods including fixed effects and generalized method of moments (GMM) estimations to address endogeneity and unobserved heterogeneity. The findings demonstrated that, when properly implemented, environmental spending has a favorable and statistically significant effect on long-term economic stability. The research concluded that, despite potential short-term financial strains, environmental spending has long-term advantages in terms of resilience and sustainability that surpass the initial expenses.

Besides, Nwankwo and Uche (2024) investigated how green budgeting might improve fiscal governance and get rid of wasteful public spending. Using a cross-country panel research design, the study focused on a sample of developing economies from 2010 to 2022, including Nigeria, Ghana, Kenya, and South Africa. Panel regression analysis and transparency index modeling were used in the study's data analysis. The study's concluded that green budgeting significantly increases fiscal transparency by making environmental spending more visible and accountable inside public financial management systems. Additionally, the study found that countries with more integrated green budgets had lower budgetary leakages and improved spending efficiency.

Olatunji and Kareem (2025) examined the dynamic relationship between green accounting, corporate governance and financial

sustainability. The study employed a time-series research design from 2000 to 2023 and used public data from the Central Bank and other government publications. The study employed Autoregressive Distributed Lag (ARDL) models to capture both short-run and long-run impacts and cointegration tests to ascertain equilibrium relationships between the variables. The study found evidence of a long-term positive association between green accounting and fiscal sustainability, suggesting that environmental investments provide substantial but delayed economic benefits.

Research Methodology

This study employs quantitative research approach to examine the effect of green accounting financial sustainability in Nigerian oil and gas firms, using corporate governance as a moderating role between 2015 and 2024. The study is limited to Nigeria as an emerging economy to obtain secondary data from the annual reports of the seven purposively selected oil and gas firms listed on the Nigerian Exchange Group (NXG) plc from 2015 to 2024. The oil and gas sector is selected for the investigation because of its essential contributions to Nigeria's economy growth and sustainability disclosure advancement. Only oil and gas firms with the available required data were taken into consideration.

The collated data were analyzed using correlation analysis, descriptive analysis, correlation analysis, Random Forest and Random effect Regression. Diagnostic tests such as Ramsey reset stability test, Hausman test, the Durbin Watson correlation test and the Augmented Dickey-Fuller group unit root test for data estimation using E-Views to run the data analysis. These analysis methods offer a strong basis for comprehending the intricate relationships that exist between green accounting, corporate governance and firms' financial sustainability in emerging markets.

Model Specification

This research adapted the econometric model employed by Oyedokun et al. (2019). The modified version of the adapted model used in this investigation is described below:

$$FSB_{it} = \beta_0 + \beta_1 GRA_{it} + \beta_2 CGV_{it} + \beta_3 GAP * CGS_{it} + \beta_4 PRO_{it} + e_{it} \dots \dots \dots (1.1)$$

Where:

FSB = Financial Sustainability of oil and gas firms i in year t;

GRA = Green accounting of Nigerian oil and gas firms i in year t;

CGV = Corporate governance Structure of Nigerian oil and gas firms i in year t;

GAP*CGS = Joint effect of GA and CGV of Nigerian oil and gas firms i in year t;

PRO = Profitability of Nigerian oil and gas firms i in year t ;
 β_0 = Constant intercept, $\beta_1 - \beta_4$ = Variable co-efficient,
 e_{it} = Stochastic error terms

Table 1: Variable Selection and Measurement

Variable	Variable Proxy	Variable Type	Variable Measurement	Literature Source
Financial Sustainability (FSB)	Altman's score	Z-Dependent	Standard Z-score model	Inokon and Umobong (2024)
Green accounting (GAC)	Environmental Expenditure	Independent	Environmental expenditure divided by operating expenses	Khalid (2025);
Corporate governance Structure (CGV)	Board independent ratio	Moderating	Ratio of Independent directors to total board size	Nwankwo and Uche (2024)
GAP*CGS	Interaction term	Moderating Effect	GA multiplying by CGV	Nwankwo and Uche (2024)
Profitability	Return on assets (ROA)	Control	Net assets divided by total assets	Nwankwo and Uche (2024)

Source: Data Compiled by Author, 2026

Results and Discussion

This section examines analyzed data displayed in tables and charts below to aid in the understanding and discussion of the findings in order to accomplish the above mentioned goals of the study.

Table 2: Descriptive Analysis

Variable	Mean	Median	S.D.	Minimum
FSB	0.681	0.641	0.183	0.312
GRA	0.673	0.623	0.172	0.312
CGV	0.703	0.642	0.192	0.331
GAP*CGS	0.473	0.310	0.033	0.103
PRO	0.681	0.624	0.171	0.334
Observations	70	70	70	70

Source: Data Generated by Author, 2026

Table 2 reports the results of descriptive statistics of the study variables across 70 firm-year observations. Financial Sustainability (FSB) has a mean of 0.681 with a standard deviation (SD) of 0.183, the median value of 0.641 and minimum of value 0.312, suggesting that while some of the sample firms maintain better financial sustainability, few of them perform below the expectation. Green accounting (GRA) has a mean of 0.673 with a median of 0.623, indicating modest and relatively consistent allocations of environmental expenditure across firms.

Corporate governance structure (CGV) records the highest mean (0.703) though variability of 0.192), indicating that the sampled firms maintain considerably diverse boards and disparate governance structures. The joint effect of GA and CGV, that is the interaction term (GAP*CGS) has the lowest mean value of 0.473 and the smallest SD of 0.033, indicating a relatively the presence of the compressed joint effect of green accounting and governance across firms. Profitability (PRO) mean (0.681) closely with FSB mean of 0.681, indicating a positive effect of earnings performance on the firms' financial resilience.

Table 3: Correlation Matrix

	FSB	GRA	CGV	GAP*CGS	PRO
FSB	1.0000	0.7334	0.91801	0.9289	0.5993
GRA	0.7334	1.0000	0.7271	0.7095	0.7111
CGV	0.9180	0.7269	1.0000	0.9975	0.6446
GAP*CGS	0.6732	0.7269	0.7271	1.0000	0.4584
PRO	0.5993	0.7111	0.6446	0.6305	1.0000

Source: Data Generated by Author, 2026

Table 3 presents correlation coefficients among the variables of this study. Corporate governance (CGV) has the strongest positive correlation (0.9180) with financial Sustainability (FSB), closely followed by the joint effect of green accounting practice and corporate governance (GAP*CGS) interaction term at 0.9289 while the green accounting (GRA)'s coefficient with FSB is 0.7334. These results indicate the closely moving of green accounting practices and governance structure in tandem with the firms' financial sustainability. Notably, green accounting practice and corporate governance structure are perfectly correlated with FSB at 0.9975, suggesting that the combination of green accounting practice and corporate governance structure largely reflects governance strength. Profitability (PRO) has a moderate positive correlation (0.5993) with FSB, implying that while earnings matter for firms' sustainability, other environmental and governance factors play a more decisive significant role. The strong inter-variable connections, specifically between CGV and GAP*CGS, assures careful interpretation of regression model justifying the absence of to avert multicollinearity issues given the study's moderation design.

Table 4: Panel Unit Root Test - ADF-Method

Variables	t-statistics	Probability
FSB	747.323	0.001
GRA	689.327	0.020
CGV	1189.25	0.021
GAP*CGS	819.782	0.000
PRO	0.17915	0.040

Source: Data Generated by Author, 2026

Table 4 discloses the result of the Panel Unit Root Test using the ADF method to determine the stationarity or otherwise of study's variables. Financial Sustainability (FSB) displayed a t-statistic of 747.323 with a probability of 0.0001. Similarly, green accounting (GRA) shows stationarity with a t-statistic of 689.327 and probability of 0.020. Corporate governance structure (CGV) has a t-statistic of 1189.25 with a probability value of 0.021. Joint effect of GA and CGV (GAP*CGS) showed a t-statistics of 819.782 with a probability value of 0.000 and profitability (PRO) has a t-statistic of 0.17915 with a probability value of 0.040. In these results, all the variables are stationary and significant at levels, affirming there is no unit root in the series.

Table 5: Other Diagnostic and Model Selection Tests

Test	Statistics	Probability	Decision
Durbin Watson Correlation	2.31440	0.4315	No autocorrelation
Hausman Test:	10.05201	0.2421	Random effect is selected
Ramsey Reset Test	1.7089	2.9202	Model is accurately described

Source: Data Generated by Author, 2026

Table 5 shows that the Durbin Watson with a statistical value of 2.31440 and the probability value of 0.4315 greater than 0.05 indicates there is no autocorrelation. The Hausman test between random effect and fixed effect accepts the null hypothesis, suggesting that random effect is fit than fixed effect for data analysis. The Ramsey RESET test verifies that the model is accurately described, indicating the absence of significant functional form mistakes.

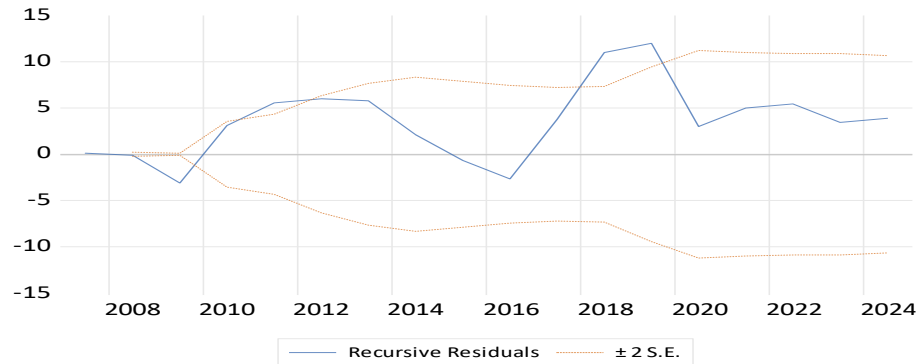


Fig 1: Random Forest Test

The Fig. 1 disclosing the random forest result illustrates the feature importance of the independent predictor variables to forecast firms' financial sustainability. Base on the results, the green accounting variables emerges as a top predictors, confirming its non-linear but influential role in shaping sustainability results. The variables of corporate governance as well rank prominently in reinforcing the findings of regression analysis. The econometric model is complemented by this machine learning approach (Random Forest model) for capturing nonlinear complex, interactions among studies' variables which may not be fully represented by a mere linear estimator. The high level predictive accuracy of the machine learning model validates the adopted general analytical framework in this study, demonstrating that the combination of machine learning techniques with traditional econometrics yields more robust results on sustainability dynamics.

Table 6: Random Effect Regression Result

$FSB_{it} = \beta_0 + \beta_1 GRA_{it} + \beta_2 CGV_{it} + \beta_3 GAP * CGS_{it} + \beta_4 PRO_{it}$				
Dependent Variable: Financial Sustainability				
Method: Random Effect				
Cross-section: 7, Period: 10				
Included observations: 70				
Variable	Coefficient	Std. Error	t-Statistic	Probability
Constant	7.81435	8.79403	0.88860	0.0023
GRA	6.74885	10.8603	0.62142	0.0024
CGV	8.44214	6.50258	1.29828	0.0017
GAP*CGS	56.9747	70.6200	0.80678	0.0000
PRO	0.795338	0.36785	2.16215	0.0136

 $R^2 = 0.804$, Adjusted $R^2 = 0.785$
F-stats. = 25.216 ($P < 0.000$)

Significance level = 5%

Source: Data Generated by Author, 2026

Table 6 reports the most fitted random effect regression results. The green accounting (GRA) coefficient is positive ($\beta = 6.749$), and significantly ($p = 0.0024$) influences the firms' financial sustainability, implying that a unit increase investment in environmental expenditure leads to 6.8% increase in the firms' financial sustainability. The coefficient of corporate governance (CGV) is also positive ($\beta = 8.442$) and has statistically significant effect ($p = 0.0017$), suggesting unit increase in the board independence leads to 8.4% improvement in sustainability outcomes. This finding is consistent with the research outcomes of Wahyuni et al. (2019); Adegbite and Salami (2023); Nwankwo and Uche (2024) establishing that adoption of green accounting practices such as environmental spending, environmental cost management, green budgeting, renewable energy allocation and recycled materials enhances spending efficiency, yields meaningful improved firm performance, contributes to favorably long-term economic stability and fiscal transparency in Nigeria. The positive significant effect of corporate governance on financial sustainability also aligns with the results of Smith and Maseko (2022) showing that supported-digital-tools robust governance structures strengthen firms' accountability in emerging countries. These findings affirm that embedded-governance frameworks responsible environmental expenditure creates more measurable long-term value rather than a mere adding to operational costs.

Most importantly, the interaction term (GAP*CGS) carries the largest positive significant ($p = 0.0000$) coefficient ($\beta = 56.975$) in the model, proving that corporate governance structures moderates and significantly amplifies the effect of green accounting on financial sustainability. The profitability (PRO) coefficient is positive ($\beta = 0.795$) and significant ($p = 0.0136$), confirming that a financially profitable firm is better positioned to maintain sustainability. The model explains 80.4% changes in financial sustainability as adjusted, confirming that the model is fit. The F-statistic of 25.216 ($p < 0.000$) indicate an independent of the regressors and baseline level of financial sustainability.

The results from this research reveal that green accounting has a positive significant effect on the financial sustainability of Nigerian oil and gas firms. The statistically significant coefficient of the interaction term indicates that corporate governance substantially moderates and amplifies the positive effect of green accounting on financial sustainability. This finding is in line with the research positions of Adegboye and Oladipo (2023); Okeke et al.

(2023); Olatunji and Kareem (2025), who reported that effective governance mechanisms are essential factors for converting environmental expenditure into tangible fiscal discipline; while profit-generating capacity underpins the environmental sustainability investments. The findings highlight that the moderating dynamic of green accounting on financial sustainability is not automatic but is conditioned by putting in place a sound corporate governance structure. This nuanced association has received limited attention in previous Nigerian oil and gas research, making the current findings an added value to the empirical literature.

The findings carry essential implications for boards of directors, corporate managers, and regulators in Nigerian oil and gas sector. The strong positive effect of the interaction term signals that firms' financial returns from investments in green accounting are greatly urge when governance mechanisms are robust. Therefore strengthen firms' board independence and reinforcing governance structures with environmental expenditure commitments simultaneously stand to attract compounded sustainability benefits. The regulators are therefore needs to develop requirements compelling sustainability disclosure to tie the environmental reporting to governance benchmarks.

This study discovers that although earnings are matter, but other environmental and governance factors also play more significant roles in improving firms' sustainability. The results confirm that more investment in environmental expenditure, stronger board independence enhance the long-term financial resilience and sustainability outcomes of emerging economies oil and gas firms. A finding provides robust evidence that corporate governance moderates the effect of green accounting on financial sustainability.

Conclusion and Recommendations

This study concludes that green accounting contributes positively to financial sustainability Nigerian oil and gas firms, while corporate governance is not just a passive structural feature but an active moderating force transforming the magnitude effect of green accounting on financial sustainability in Nigerian oil and gas sector. Any oil and gas firms in emerging economies that align their environmental expenditure with sound governance practices are in best positions to withstand environmental regulatory pressures, achieve long-term viability and generate stable financial returns. This study points to the importance of institutional strengthening and the reinforcement of relevance sustainability frameworks as a prerequisite for making financial gains out of environmental investments in emerging economies. The adopted panel regression and random forest methodological approaches in this study further affirm the

value of integrating econometric-machine learning techniques in sustainability empirical research.

This research recommends that Nigerian governments should design fiscal incentive packages like preferential financing rates and tax deductions to reward any oil and gas firm that meet the defined governance quality and environmental expenditure investments thresholds to encourage firms pursue green accounting thereby accelerating the oil and gas sector's transformation to more sustainable operations. Also, the regulatory bodies should institutionalize and enforce sustainability sector-specific reporting requirements for Nigerian oil and gas firms that will explicitly connect the minimum governance benchmarks like board independence with environmental expenditure disclosure, compelling firms to strengthen both dimensions rather than considering them as a separate obligatory compliance.

The managers of Nigerian oil and gas firms should be encouraged, through listing requirements or regulatory guidance to constitute dedicated green accounting or sustainability sub-committees at board level because of the study's result that governance structure significantly amplifies the firms' financial returns of green accounting by having environmental finance expertise with independent directors overseeing the environmental expenditure decisions in order to ensure that resources are efficiently allocated and that commitment to sustainability translate into meaningful enhancement in financial resilience.

This research is one of the most recent empirical studies to establish that corporate governance significantly moderates the effect of green accounting on financial sustainability Nigerian firms through the testing of interaction green accounting practice and governance structure using econometric model. The findings inform the oil and gas stakeholders that green accounting practice is strongly conditioned by governance quality. The study adds feather to research methodological approach by incorporating random forest machine learning with random effect regression to assess sustainability determinants which demonstrates that machine learning tools can complement the traditional panel econometrics methods to capture the nonlinear relationships and provide a more robust analytical tools for sustainability research in emerging economy environments than what either method alone would accommodate. Besides, the study proposes a balanced environmental factor to extend the theoretical framework beyond general corporate sustainability coverage through the application of sustainability theory in a constrained governance, resource-intensive institution-specific oil and gas setting in Nigeria.

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