

Effect of Environmental Remediation and Sustainability Investments on the Operational Performance of Oil and Gas Firms in Nigeria

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Abstract

This study examined the effect of environmental remediation and sustainability investments on the operational performance of Oil and Gas Firms in Nigeria. Specifically, the study assessed the effect of environmental remediation costs, environmental investment costs, and community development and corporate social responsibility (CSR) costs on the production volume (output) of selected firms. The study adopted an ex-post facto research design and utilized secondary data obtained from the annual reports and accounts of five sampled oil and gas firms: Conoil, Mobil, Japaul Oil, MRS Oil, and Total Nigeria Plc, covering the period from 2010 to 2024. Panel data analysis was conducted using Panel Least Squares (PLS) regression under a fixed effects model. The empirical results revealed that environmental remediation costs (ERC) have a positive and statistically significant effect on production volume, with a t-statistic of 8.8321 and a p-value of 0.0000, indicating that increased spending on environmental clean-up and restoration enhances production efficiency. In contrast, environmental investment costs (EIC) exhibited a negative but statistically significant effect on production output, with a t-statistic of -6.6960 and a p-value of 0.0000, suggesting that such investments may impose short-term operational constraints despite their long-term benefits. Furthermore, community development and CSR costs (CDCSR) showed a negative and statistically insignificant effect on production volume, with a t-statistic of -0.9647 and a p-value of 0.3382, implying that these expenditures do not have a direct measurable impact on production within the study period. The model demonstrated a strong explanatory power, with an R-squared value of 0.8962, indicating that approximately 89.62% of the variation in production output is explained by the included environmental cost variables. The findings suggest that while environmental remediation activities significantly enhance operational performance, other environmental expenditures require strategic management to optimize their impact. The study concludes that oil and gas firms in Nigeria should prioritize environmental remediation efforts while adopting a strategic and phased approach to environmental investments and CSR activities. This will ensure a balance between environmental sustainability and operational efficiency, thereby improving overall firm performance.

Keywords: Environmental Remediation, Sustainability Investments, Corporate Social Responsibility, Operational Performance, Production Volume.

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Introduction

The oil and gas industry remains a critical pillar of the Nigerian economy, contributing significantly to government revenue, foreign exchange earnings, and employment generation (Olayungbo, 2019; Adedoyin et al., 2020). Despite its economic importance, the sector has been widely criticized for its environmental footprint, particularly in the Niger Delta region, where decades of oil exploration and production have resulted in oil spills, gas flaring, land degradation, and water contamination (UNEP, 2019; Okonkwo et al., 2021). These environmental challenges have not only disrupted local livelihoods but have also intensified concerns over the sustainability of oil and gas operations in Nigeria (Eze et al., 2020).

In response to these environmental concerns, oil and gas firms increasingly incur various categories of environmental costs aimed at mitigating, managing, and correcting environmental damage (Adebayo & Ologun, 2021). Among these are environmental remediation costs, which involve expenses related to the cleanup of oil spills, restoration of degraded ecosystems, and decommissioning of contaminated sites (UNEP, 2019). These costs are particularly significant in Nigeria, where historical pollution has created a backlog of remediation obligations. Recent reports indicate that substantial financial resources are required to address legacy environmental damage in the Niger Delta, highlighting the financial implications of remediation activities for oil and gas firms (World Bank, 2020).

In addition to remediation efforts, firms are also investing in environmental assets and technologies designed to reduce environmental degradation. These environmental investment costs include expenditures on pollution control equipment, gas capture technologies, and waste management systems (Adams et al., 2018). Such investments are often capital-intensive but are increasingly viewed as strategic tools for enhancing operational efficiency, reducing regulatory risks, and improving long-term sustainability (IEA, 2023). With growing global emphasis on environmental responsibility and energy transition, oil and gas companies in Nigeria are under pressure to adopt cleaner technologies and align with international environmental standards (Adedoyin et al., 2020).

Furthermore, oil and gas firms engage in community development and corporate social responsibility (CSR) initiatives as part of their environmental and social obligations (Idemudia & Osayande, 2018). These expenditures, which include donations, infrastructure development, educational programs, and healthcare support for host communities, are aimed at fostering positive relationships and maintaining a social license to operate (Amaeshi et al., 2016). In regions like the Niger Delta, where community grievances over environmental degradation are prevalent, CSR-related costs have become an essential component of corporate strategy. However, the extent to which such expenditures translate into improved operational performance remains an area of ongoing debate (Nwadior & Igwe, 2017).

The Nigerian government has introduced several regulatory frameworks to ensure environmental accountability in the oil and gas sector, including the Petroleum Industry Act (PIA) of 2021, which mandates environmental remediation, host community development, and sustainable operational practices. Regulatory bodies such as the Nigerian Upstream Petroleum Regulatory Commission (NUPRC) have also strengthened compliance requirements, particularly in areas related to environmental restoration and asset retirement (NUPRC, 2022). Despite these efforts, enforcement challenges and financial constraints continue to affect the effective implementation of environmental policies (Okonkwo et al., 2021).

The relationship between environmental costs and operational performance has attracted increasing attention in recent literature. While some studies suggest that environmental investments and remediation efforts can enhance efficiency and reduce operational risks, others argue that the high costs associated with these activities may negatively impact short-term performance (Adebayo & Ologun, 2021; Adams et al., 2018). In Nigeria, fluctuating oil prices, declining capital inflows, and increasing regulatory demands have created a complex environment in which firms must balance profitability with environmental responsibility (Nairametrics, 2023).

Against this backdrop, it becomes imperative to examine how specific components of environmental costs, namely environmental remediation costs, environmental investment costs, and community development (CSR) expenditures, affect the operational performance of oil and gas firms in Nigeria. This study, therefore, seeks to provide empirical evidence on the extent to which these environmental cost components influence production output, thereby contributing to policy formulation and strategic decision-making for sustainable development in the Nigerian oil and gas sector.

Statement of the Problem

The environmental challenges associated with oil and gas operations in Nigeria have persisted for decades, particularly in the Niger Delta region, where oil spills, gas flaring, and ecosystem degradation remain widespread. Despite increased regulatory efforts and growing global attention to environmental sustainability, many oil and gas firms continue to face significant environmental liabilities. These liabilities often translate into substantial environmental costs, especially in the form of remediation expenses, investments in environmentally friendly technologies, and community development obligations.

Environmental remediation costs, in particular, have become a major financial burden for oil and gas companies operating in Nigeria. The need to clean up oil spills, restore polluted lands, and decommission obsolete facilities requires significant capital outlays. However, many firms have been criticized for delays or inadequacies in remediation efforts, raising concerns about both environmental accountability and the potential impact of these costs on operational efficiency. The extent to which such remediation expenditures influence production output remains insufficiently examined in empirical literature.

Similarly, environmental investment costs such as expenditures on pollution control equipment, gas capture infrastructure, and waste management systems are increasingly necessary for compliance with environmental regulations and international best practices. While these investments are expected to improve operational efficiency and reduce environmental risks over time, they require substantial upfront capital. In a context characterized by fluctuating oil prices and declining capital inflows, such as Nigeria's oil and gas sector, these financial commitments may pose challenges to firms' short-term operational performance.

In addition, oil and gas companies incur significant costs on community development and corporate social responsibility initiatives aimed at addressing the socio-environmental impacts of their operations. These expenditures are often directed toward infrastructure development, education, healthcare, and other social programs in host communities. Although such initiatives are intended to enhance corporate reputation and ensure a stable operating environment, there is ongoing debate as to whether these costs yield measurable improvements in operational performance, particularly in terms of production output.

Despite the growing importance of these environmental cost components, existing studies in Nigeria have largely focused on more conventional proxies such as pollution prevention costs, employee health and safety expenses, and environmental awareness programs. Consequently, there is limited empirical evidence on how environmental remediation costs, environmental investment costs, and community development expenditures individually and collectively affect the operational performance of oil and gas firms in Nigeria.

This gap in the literature creates a critical need for further investigation, particularly in light of evolving regulatory frameworks such as the Petroleum Industry Act (PIA) of 2021, which places greater emphasis on environmental remediation and host community development. Without a clear understanding of how these environmental cost components influence production output, policymakers and industry stakeholders may struggle to design effective strategies that balance environmental sustainability with operational efficiency.

It is against this backdrop that this study seeks to examine the effect of environmental remediation costs, environmental investment costs, and community development expenditures on the operational performance of oil and gas firms in Nigeria.

Objectives of the Study

The broad objective of this study is to examine the effect of environmental cost components on the operational performance of oil and gas firms in Nigeria. The specific objectives are to:

- i. Examine the effect of environmental remediation costs on the production volume (output) of oil and gas firms in Nigeria.
- ii. Assess the effect of environmental investment costs on the production volume (output) of oil and gas firms in Nigeria.
- iii. Investigate the effect of community development and corporate social responsibility (CSR) costs on the production volume (output) of oil and gas firms in Nigeria.

Research Questions

The study seeks to provide answers to the following questions:

- i. What effect do environmental remediation costs have on the production volume (output) of oil and gas firms in Nigeria?
- ii. To what extent do environmental investment costs influence the production volume (output) of oil and gas firms in Nigeria?
- iii. How do community development and CSR costs affect the production volume (output) of oil and gas firms in Nigeria?

Research Hypotheses

The following null hypotheses are formulated:

- i. Environmental remediation costs have no significant effect on the production volume (output) of oil and gas firms in Nigeria.
- ii. Environmental investment costs have no significant effect on the production volume (output) of oil and gas firms in Nigeria.
- iii. Community development and CSR costs have no significant effect on the production volume (output) of oil and gas firms in Nigeria.

Scope of the Study

This study examines the effect of environmental cost components on the operational performance of oil and gas firms in Nigeria over the period 2010 to 2024. Specifically, the study focuses on environmental remediation costs, environmental investment costs, and community development and corporate social responsibility (CSR) expenditures, and their influence on production volume as a proxy for operational performance.

The study relies on secondary data obtained from publicly available sources, including annual financial statements, sustainability reports, and other relevant disclosures of selected oil and gas firms operating in Nigeria. The selected time frame captures both pre- and post-reform periods, including developments following the enactment of the Petroleum Industry Act (PIA) of 2021, which introduced significant changes in environmental regulation and host community engagement within the industry.

The study is limited to oil and gas firms operating within Nigeria that have consistently published financial and environmental information throughout the study period. Firms with incomplete or inconsistent data are excluded to ensure the reliability of the analysis. Additionally, the study does not cover firms outside Nigeria or companies in other sectors, thereby restricting the generalizability of the findings to the Nigerian oil and gas industry.

Review of Related Literature

Conceptual Review

Environmental Costs

Environmental costs refer to expenditures incurred by firms to prevent, control, and remediate environmental damage arising from their operational activities. These costs include both capital and revenue expenditures related to environmental protection, regulatory compliance, and sustainability initiatives (Adebayo & Ologun, 2021). In the oil and gas industry, environmental costs are particularly significant due to the high environmental risks associated with exploration, production, and distribution activities. These costs are increasingly recognized as essential components of corporate strategy, as firms strive to balance profitability with environmental responsibility.

Environmental Remediation Costs

Environmental remediation costs are expenses incurred in restoring polluted environments to their original or acceptable conditions. These include costs associated with oil spill cleanups, soil and groundwater restoration, and decommissioning of contaminated facilities (UNEP, 2019). In Nigeria, remediation costs have become substantial due to the long history of environmental degradation in the Niger Delta. Effective remediation is critical not only for regulatory compliance but also for maintaining corporate legitimacy and avoiding operational disruptions caused by community conflicts (Okonkwo et al., 2021).

Environmental Investment Costs

Environmental investment costs refer to capital expenditures on assets and technologies aimed at reducing environmental degradation. These include investments in pollution control equipment, gas capture systems, waste management infrastructure, and cleaner production technologies (Adams et al., 2018). Such investments are often viewed as proactive environmental strategies that can enhance operational efficiency, reduce waste, and minimize regulatory penalties. However, their high initial cost may pose short-term financial challenges for firms, especially in capital-constrained environments like Nigeria's oil and gas sector.

Community Development and CSR Costs

Community development and corporate social responsibility (CSR) costs refer to expenditures incurred by firms to support host communities and address the social impacts of their operations. These costs include investments in education, healthcare, infrastructure, and social welfare programs (Idemudia & Osayande, 2018). In the Nigerian oil and gas industry, CSR initiatives are crucial for maintaining peaceful relationships with host communities and ensuring uninterrupted operations. However, there is ongoing debate regarding whether such expenditures translate into tangible improvements in firm performance (Nwadiakor & Igwe, 2017).

Operational Performance

Operational performance refers to the efficiency and effectiveness with which a firm utilizes its resources to achieve desired outputs. In the context of this study, operational performance is measured using production volume (output), which reflects the firm's ability to maintain and increase production levels despite environmental and regulatory constraints (Eze et al., 2020). Production output is particularly relevant in the oil and gas industry, where operational efficiency directly impacts profitability and sustainability.

Theoretical Review

This study is anchored on the Stakeholder Theory as propounded by R. Edward Freeman (1984). The theory posits that the success and sustainability of an organization depend on its ability to effectively manage relationships with various stakeholders, including shareholders, employees, customers, regulators, and host communities. It

emphasizes that firms should not focus solely on profit maximization but must also consider the interests and expectations of all parties affected by their operations.

Recent studies have extended the relevance of Stakeholder Theory by emphasizing that firms' engagement in environmental and social responsibilities is driven by increasing stakeholder pressure and regulatory expectations (Amaeshi et al., 2016; Idemudia & Osayande, 2018). In the context of the Nigerian oil and gas industry, where operations have significant environmental and social consequences, stakeholders—including government agencies, host communities, and environmental advocacy groups—demand responsible corporate behavior, particularly in relation to environmental sustainability and community development.

Environmental remediation costs, environmental investment costs, and community development (CSR) expenditures can therefore be viewed as strategic responses by firms to meet stakeholder expectations. For instance, remediation activities address concerns related to environmental degradation, while investments in environmentally friendly technologies demonstrate commitment to sustainable practices. Similarly, community development and CSR initiatives are undertaken to maintain peaceful relationships with host communities and secure a social license to operate (Okonkwo et al., 2021).

The application of Stakeholder Theory in this study provides a framework for understanding why oil and gas firms in Nigeria incur substantial environmental costs beyond mere regulatory compliance. By responding to stakeholder demands, firms can reduce operational risks such as community unrest, regulatory sanctions, and production disruptions, thereby enhancing operational performance and production output (Eze et al., 2020).

Consequently, Stakeholder Theory offers a robust foundation for analyzing the relationship between environmental cost components: environmental remediation costs, environmental investment costs, and community development (CSR) expenditures and the operational performance of oil and gas firms in Nigeria.

Empirical Review

Environmental Remediation Costs and Production Output

Studies have shown mixed evidence on the relationship between environmental remediation costs and firm performance in the Nigerian oil and gas sector. Ubokudom et al. (2024) examined environmental remediation costs and financial performance of listed oil and gas firms in Nigeria and found that environmental cleanup and safety-related costs significantly influence return on assets, suggesting that remediation activities may enhance long-term operational stability through improved environmental compliance and reduced disruption risks.

Similarly, Korolo and Korolo (2022) investigated environmental remediation costs and financial performance of oil and gas companies in Nigeria using return on assets as a proxy. Their findings revealed that environmental pollution prevention and detection costs have varying effects, with detection-related remediation activities showing a more positive and significant relationship with performance than prevention costs.

In another study, Owota and Mansi (2025) assessed environmental remediation and waste management costs in relation to firm value in the Nigerian oil and gas industry. The study found that remediation expenditures positively influence firm value, indicating that firms that invest more in environmental restoration tend to experience improved market perception and operational stability.

Adebayo and Ologun (2021) also observed that environmental remediation efforts help firms reduce regulatory sanctions and operational shutdown risks, thereby indirectly improving production continuity and operational output. However, they noted that high remediation costs may exert short-term financial pressure on firms.

Furthermore, Eze et al. (2020) emphasized that firms operating in highly polluted environments often experience production disruptions due to environmental conflicts, and remediation investments help restore operational continuity over time.

Adebayo and Ologun (2021) investigated the impact of environmental costs on firm performance in Nigeria and found that environmental expenditures have a significant positive effect on operational efficiency, suggesting that proactive environmental management enhances productivity. Similarly, Adams et al. (2018) reported that environmental investment improves firm performance by reducing waste and enhancing resource efficiency.

In contrast, Nwadiolor and Igwe (2017) found that certain environmental costs, particularly those related to compliance and remediation, may have a negative impact on short-term financial performance due to their high cost implications. This suggests that while environmental responsibility is beneficial in the long run, it may constrain immediate operational outcomes.

Environmental Investment Costs and Production Output

Empirical studies have also examined the effect of environmental investment costs on firm performance, particularly in relation to operational efficiency and production output. Adams et al. (2018) found that investment in environmental technologies such as pollution control systems and waste treatment facilities improves operational efficiency by reducing waste and enhancing resource utilization.

In the Nigerian oil and gas context, Owota et al. (2025) examined environmental investment and firm value and reported a positive relationship between environmental capital investment and firm performance, suggesting that firms adopting cleaner technologies tend to achieve better long-term operational outcomes.

Similarly, Nwadiolor and Igwe (2017) noted that although environmental investment costs may reduce short-term profitability due to high capital outlays, they contribute positively to long-term productivity and operational sustainability.

IEA (2023) also highlighted that investments in gas capture and emission reduction technologies are becoming critical for improving efficiency in oil-producing countries like Nigeria, where environmental compliance costs are rising due to stricter regulations.

Furthermore, Adedoyin et al. (2020) found that firms that invest in environmental management systems experience improved production stability and reduced downtime, as such investments minimize environmental-related operational disruptions.

Community Development (CSR) Costs and Production Output

Empirical findings on community development and CSR costs show that they play a critical role in shaping operational performance in the Nigerian oil and gas industry. Idemudia and Osayande (2018) found that CSR investments improve firm-community relations, which reduces operational disruptions such as protests, vandalism, and sabotage, thereby enhancing production continuity.

Similarly, Amaeshi et al. (2016) observed that CSR expenditures in host communities serve as a “social license to operate,” which is essential for sustaining uninterrupted production in environmentally sensitive regions like the Niger Delta.

A recent study by Asuquo et al. (2024) revealed that community development costs positively affect firm performance, as companies that invest in infrastructure and social welfare projects tend to experience fewer operational interruptions.

Nwadiakor and Igwe (2017) also reported that CSR-related expenditures may not immediately improve financial returns but significantly reduce operational risks linked to community conflicts, thereby stabilizing production output over time.

Okonkwo et al. (2021) examined environmental practices in the Nigerian oil and gas sector and concluded that remediation and community-related expenditures are essential for reducing operational risks associated with community unrest and regulatory sanctions. Their findings highlight the indirect benefits of environmental costs in ensuring operational stability.

Furthermore, Eze et al. (2020) found that firms that invest in environmentally friendly technologies tend to experience improved production efficiency over time. This supports the argument that environmental investment costs, although capital-intensive, contribute positively to operational performance in the long run.

Finally, Okonkwo et al. (2021) emphasized that CSR investments are essential for mitigating environmental justice issues in oil-producing communities, which indirectly supports sustained production activities by reducing resistance from host communities.

Gap in Literature

Despite extensive literature on environmental costs and corporate performance, several gaps remain within the context of Nigeria's oil and gas industry. Most existing studies have concentrated on financial performance indicators such as return on assets (ROA), return on equity (ROE), and earnings per share (EPS), with limited attention given to operational performance measures such as production volume, which is a more direct reflection of efficiency and output in the oil and gas sector.

Furthermore, environmental costs in previous studies are often treated as aggregated constructs, thereby masking the distinct effects of individual components such as environmental remediation costs, environmental investment costs, and community development or corporate social responsibility (CSR) expenditures. This aggregation limits a more nuanced understanding of how specific environmental expenditures influence operational outcomes differently, particularly in capital-intensive industries like oil and gas.

In addition, a considerable portion of existing empirical evidence is drawn from developed economies or multinational corporations, where regulatory frameworks, technological advancement, and environmental compliance systems differ significantly from those in emerging economies such as Nigeria. This creates a contextual gap, as findings from such environments may not fully capture the realities and operational dynamics of Nigerian oil and gas firms.

Moreover, limited studies have simultaneously examined environmental remediation costs, environmental investment costs, and CSR-related expenditures within a single analytical framework in relation to production output. This leaves a gap in understanding the combined and relative effects of these environmental cost components on operational performance.

This study addresses these gaps by focusing specifically on oil and gas firms operating in Nigeria over the period 2010 to 2024. It adopts production volume as a proxy for operational performance and disaggregates environmental costs into environmental remediation costs, environmental investment costs, and community development (CSR) expenditures. By doing so, the study provides context-specific empirical evidence that will assist policymakers, regulators, and industry managers in understanding the operational implications of environmental expenditures in the Nigerian oil and gas sector.

Methodology

Research Design

This study adopted an *ex post facto* research design, which involves the analysis of existing data and historical events without manipulation of the independent or dependent variables. The design is appropriate because the study seeks to examine the effect of environmental cost components on the operational performance of oil and gas firms based on historical financial information. Since the variables already exist and cannot be controlled or altered by the researcher, the *ex post facto* approach provides a suitable framework for establishing relationships among the variables.

Area of Study

The study was conducted in Nigeria and focuses specifically on oil and gas firms operating within the Nigerian economy. These firms are selected due to their significant environmental impact and their substantial contribution to national output and revenue generation.

Sources of Data

This study relied exclusively on secondary data obtained from audited annual reports and financial statements of selected oil and gas firms in Nigeria. The data covered a period of fifteen (15) years, from 2010 to 2024, ensuring sufficient time variation for robust panel data analysis.

Population of the Study

The population of the study consists of all oil and gas firms listed on the Nigerian Exchange Group (NGX) as of 31st December 2024. At the time of the study, thirteen (13) oil and gas firms were listed, including Conoil, Mobil, Capital Oil, Caverton, Conoil, Eterna, Forte Oil, Japaul Oil, MRS Oil, Oando, Rak Unity, Seplat, and Total Nigeria Plc.

Determination of Sample Size

A purposive sampling technique was employed to select firms with complete and consistent financial and environmental data for the period under review (2010–2024). Out of the thirteen (13) listed firms, five (5) firms were selected based on data availability and consistency. These include Conoil, Mobil, Japaul Oil, MRS Oil, and Total Nigeria Plc. This selection ensures reliability, comparability, and completeness of data used for analysis.

Model Specification

The study employs a panel data regression model to examine the effect of environmental cost components on operational performance, proxied by production volume (output). A fixed effects estimation technique is adopted.

The model is specified as:

$$PV_{it} = \beta_0 + \beta_1 ERC_{it} + \beta_2 EIC_{it} + \beta_3 CDCSR_{it} + \mu_i + \varepsilon_{it} \dots\dots\dots(i)$$

Where:

- PV_{it} = Production Volume (output) of firm i at time t
- ERC_{it} = Environmental Remediation Costs of firm i at time t
- EIC_{it} = Environmental Investment Costs of firm i at time t
- $CDCSR_{it}$ = Community Development and CSR Costs of firm i at time t

μ_i	=	Firm-specific fixed effects (unobserved heterogeneity)
ϵ_{it}	=	Error term
i	=	Firm
t	=	Time period

Description of Variables

- i. Production Volume (PV): This is the dependent variable and represents the operational performance of oil and gas firms, measured in terms of output or production level.
- ii. Environmental Remediation Costs (ERC): This refers to expenditures incurred in cleaning up oil spills, restoring degraded environments, and decommissioning contaminated sites.
- iii. Environmental Investment Costs (EIC): This captures capital expenditures on environmental protection technologies such as pollution control systems, gas capture equipment, and waste management infrastructure.
- iv. Community Development and CSR Costs (CDCSR): This represents expenditures made on host community development, including infrastructure provision, education, healthcare, and other social responsibility initiatives.

Rationale for Fixed Effects Model

The fixed effects model was adopted to control for unobserved firm-specific characteristics that are constant over time but may influence operational performance. These include managerial efficiency, organizational culture, and institutional structures. By focusing on within-firm variations, the model ensures that the estimated coefficients reflect the impact of changes in environmental costs on production output, rather than differences across firms. This makes the model particularly suitable for panel data analysis in the Nigerian oil and gas sector.

Method of Data Analysis

The study employed Panel Least Squares (PLS) regression analysis with a fixed effects specification. This method is appropriate for examining the relationship between environmental cost variables and operational performance over time and across firms.

Decision Rule for Hypotheses Testing

The decision rule for hypothesis testing is based on the probability value (p-value) of the t-statistics. The null hypothesis is rejected if the p-value is less than 0.05 significance level; otherwise, it is accepted. This implies that a p-value less than 0.05 indicates a statistically significant relationship between the variables.

Data Presentation and Analysis

Data Presentation

Table 1. Panel Data Regression Analysis Result of the sampled Oil and Gas Firms

Dependent Variable: PV

Method: Panel Least Squares

Date: 05/21/26 Time: 16:08

Sample: 2010 2024

Periods included: 15

Cross-sections included: 5

Total panel (balanced) observations: 75

White cross-section standard errors & covariance (no d.f. correction)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ERC	1.912650	0.216558	8.832055	0.0000
EIC	-0.450016	0.067207	-6.695960	0.0000
CDCSR	-0.153205	0.158818	-0.964656	0.3382
C	1.517846	0.316560	4.794812	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.896174	Mean dependent var	6.643992
Adjusted R-squared	0.895774	S.D. dependent var	0.264809
S.E. of regression	0.017215	Akaike info criterion	-5.185590
Sum squared resid	0.019855	Schwarz criterion	-4.938391
Log likelihood	202.4596	Hannan-Quinn criter.	-5.086886
F-statistic	2491.985	Durbin-Watson stat	0.844701
Prob(F-statistic)	0.000000		

Source: E-views 14.0 Statistical Output, 2026

Table 1 presents the panel data regression results on the effect of environmental cost components on the production volume of the sampled oil and gas firms in Nigeria.

The result shows that Environmental Remediation Costs (ERC) have a positive and statistically significant effect on production volume, with a t-statistic of 8.8321 and a p-value of 0.0000. This implies that increased spending on environmental remediation activities such as oil spill clean-up and environmental restoration enhances production output. The positive relationship suggests that maintaining a cleaner and compliant operational environment reduces disruptions and improves efficiency, thereby supporting higher production levels.

In contrast, Environmental Investment Costs (EIC) exhibit a negative and statistically significant relationship with production volume, as indicated by a t-statistic of -6.6960 and a p-value of 0.0000. This suggests that higher investments in environmental technologies and infrastructure may initially reduce production output. This could be due to the high capital requirements, operational adjustments, or temporary disruptions associated with implementing new environmental systems, which may affect short-term production efficiency.

Furthermore, Community Development and Corporate Social Responsibility Costs (CDCSR) show a negative but statistically insignificant effect on production volume, with a t-statistic of -0.9647 and a p-value of 0.3382. This indicates that although CSR expenditures may contribute to social goodwill and community relations, they do not have a direct or measurable impact on production output within the period under review.

The coefficient of determination (R-squared) of 0.8962 indicates that approximately 89.62% of the variations in production volume are explained by the environmental cost variables included in the model. The adjusted R-squared of 0.8958 further confirms the strong explanatory power of the model after adjusting for degrees of freedom.

The F-statistic value of 2491.985 with a probability of 0.000000 indicates that the model is statistically significant overall, implying that the independent variables jointly have a significant effect on production volume.

However, the Durbin-Watson statistic of 0.8447 suggests the presence of positive serial autocorrelation in the model. This indicates that there may be some correlation in the error terms over time, which could affect the efficiency of the estimates and may require further diagnostic testing or model adjustments.

Test of Hypotheses

Test of Hypothesis One

Restatement of Hypothesis

Ho₁: Environmental remediation costs have no significant effect on the production volume (output) of oil and gas firms in Nigeria.

Ha₁: Environmental remediation costs have significant effect on the production volume (output) of oil and gas firms in Nigeria.

Statement of Decision Rule: Reject the null hypothesis (H_0) if the p-value of the t-statistics is less than 0.05. Otherwise, accept the null hypothesis and reject the alternate hypothesis.

Decision: The regression results in Table 4.1 indicate that Environmental Remediation Costs (ERC) have a positive and statistically significant effect on production volume. The t-statistic is 8.8321 and the p-value is 0.0000, which is less than 0.05. Therefore, the null hypothesis (H_{01}) is rejected, while the alternative hypothesis is accepted.

This implies that increased spending on environmental remediation activities significantly improves production output. It suggests that firms that invest in cleaning and restoring the environment experience fewer operational disruptions and improved efficiency.

Test of Hypothesis Two

Restatement of Hypothesis

Ho₂: Environmental investment costs have no significant effect on the production volume (output) of oil and gas firms in Nigeria.

Ha₂: Environmental investment costs have significant effect on the production volume (output) of oil and gas firms in Nigeria.

Statement of Decision Rule: Reject the null hypothesis (H_0) if the p-value of the t-statistics is less than 0.05. Otherwise, accept the null hypothesis and reject the alternate hypothesis.

Decision: The regression results show that Environmental Investment Costs (EIC) have a negative and statistically significant effect on production volume. The t-statistic is -6.6960 and the p-value is 0.0000, which is less than 0.05. Therefore, the null hypothesis (H_{02}) is rejected, while the alternative hypothesis is accepted.

This indicates that environmental investment costs significantly influence production output, but in a negative direction. This suggests that high capital expenditures on environmental technologies may reduce production in the short run due to installation costs, operational adjustments, or resource reallocation.

Test of Hypothesis Three

Restatement of Hypothesis

H₀₃: Community development and CSR costs have no significant effect on the production volume (output) of oil and gas firms in Nigeria.

H_{a3}: Community development and CSR costs have significant effect on the production volume (output) of oil and gas firms in Nigeria.

Statement of Decision Rule: Reject the null hypothesis (H_0) if the p-value of the t-statistics is less than 0.05. Otherwise, accept the null hypothesis and reject the alternate hypothesis.

Decision: The regression results reveal that Community Development and CSR Costs (CDCSR) have a negative but statistically insignificant effect on production volume. The t-statistic is -0.9647 and the p-value is 0.3382, which is greater than 0.05. Therefore, the null hypothesis (H_{03}) is accepted, while the alternative hypothesis is rejected.

This implies that CSR expenditures do not have a statistically significant impact on production output within the study period.

Discussion of Findings

The findings of this study reveal that Environmental Remediation Costs (ERC) have a positive and significant effect on the production volume of Nigerian oil and gas firms. The p-value of 0.0000 confirms that remediation efforts such as environmental clean-up and restoration enhance operational efficiency. This finding suggests that maintaining environmental integrity reduces disruptions and supports sustained production activities.

In contrast, Environmental Investment Costs (EIC) were found to have a negative but significant effect on production output, as indicated by a p-value of 0.0000. This implies that although such investments are necessary for long-term sustainability and regulatory compliance, they may impose short-term financial and operational burdens that reduce immediate production efficiency.

Furthermore, Community Development and CSR Costs (CDCSR) exhibited a negative and insignificant relationship with production volume, with a p-value of 0.3382. This suggests that while CSR activities may improve corporate image and stakeholder relations, they do not directly translate into increased production output within the period under study.

Therefore, the results indicate that not all environmental expenditures have the same effect on operational performance. While remediation costs enhance production efficiency, investment costs may constrain output in the short term, and CSR expenditures appear to have no direct operational impact. These findings highlight the need for oil and gas firms to strategically manage environmental expenditures to balance sustainability objectives with operational performance.

Summary of Findings, Conclusion and Recommendations

Summary of Findings

The findings arising from this research are summarized as follows:

- i. Environmental Remediation Costs (ERC) have a positive and statistically significant impact on the production volume of selected oil and gas firms in Nigeria, with a p-value of 0.0000 (< 0.05) and a t-statistic of 8.8321 (> 2). This indicates that expenditures on environmental clean-up and restoration enhance operational efficiency and production output.
- ii. Environmental Investment Costs (EIC) have a negative but statistically significant effect on production volume, as evidenced by a p-value of 0.0000 (< 0.05) and a t-statistic of -6.6960 (< -2). This suggests that although such investments are necessary, they may reduce production output in the short run due to high capital requirements and operational adjustments.
- iii. Community Development and CSR Costs (CDCSR) exhibit a negative and statistically insignificant relationship with production volume, with a p-value of 0.3382 (> 0.05) and a t-statistic of -0.9647 (< 2). This implies that CSR expenditures do not significantly influence production output within the period under study.

Conclusion

This study examined the effect of environmental cost components on the production output of listed oil and gas firms in Nigeria. The findings reveal that environmental costs do not have a uniform impact on operational performance.

Specifically, environmental remediation costs were found to significantly enhance production output, highlighting the importance of maintaining a clean and compliant operational environment. In contrast, environmental investment costs showed a significant but negative effect on production, indicating that such expenditures may impose short-term operational and financial constraints despite their long-term benefits. Meanwhile, community development and CSR costs were found to have no significant effect on production output, suggesting that their benefits may be indirect or long-term rather than immediately reflected in operational performance.

Therefore, the study concludes that while environmental responsibility is essential, oil and gas firms must strategically allocate environmental expenditures to balance sustainability objectives with operational efficiency. Environmental remediation emerges as a critical driver of productivity, while investment and CSR-related expenditures require careful planning to optimize their impact.

Recommendations

In light of the study's findings, the following recommendations are made:

- i. Given the positive and significant effect of Environmental Remediation Costs (ERC) on production output, oil and gas firms in Nigeria should increase investments in environmental clean-up and restoration activities. This includes prompt oil spill response, site rehabilitation, and pollution control measures, which can reduce operational disruptions and enhance production efficiency.
- ii. Since Environmental Investment Costs (EIC) were found to have a negative but significant effect on production, firms should adopt a phased and strategic approach to environmental investments. This may involve spreading capital expenditures over time, integrating cost-effective technologies, and ensuring that such investments do not significantly disrupt production activities in the short run.
- iii. Given that Community Development and CSR Costs (CDCSR) do not have a significant direct impact on production, firms should restructure their CSR initiatives to align more closely with operational objectives. Emphasis should be placed on projects that improve community relations, reduce conflicts, and create a stable operating environment, thereby generating indirect benefits for production performance.

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