
Original Research Article

AN ECONOMETRIC ASSESSMENT OF THE NEXUS BETWEEN COST OPTIMIZATION AND OIL REVENUE IN NIGERIA'S OIL AND GAS INDUSTRY

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Abstract: This study examined the impact of cost optimization on revenue generation in Nigeria's oil and gas industry using econometric techniques. The persistent volatility in global oil prices and inefficiencies in operational cost structures have made cost optimization a critical factor for sustaining revenue growth. The analytical framework of this study is based on econometric methodology, encompassing an error-correction model of regression analysis, using data from 1980 to 2025. The Granger Causality test and cointegration technique were used to analyze the impact of cost optimization strategies in the oil and gas industry on oil revenue in Nigeria within the period under review. The findings reveal that effective cost optimization significantly enhances revenue performance, while exchange rate volatility negatively affects oil revenue. The study recommended improved cost management frameworks, technological adoption, and policy reforms in the oil and gas industry to stabilize the oil and gas industry in Nigeria.

Keywords: Cost optimization, Oil revenue, Capital expenditure, Operational Cost, Exchange rate, Crude oil price.

1. INTRODUCTION

Nigeria's economy is heavily dependent on the oil and gas sector, which contributes a significant proportion of government revenue and foreign exchange earnings. However, rising operational costs, inefficiencies, and global oil price fluctuations have constrained revenue maximization. Cost optimization strategies such as operational efficiency, technological innovation, and cost control have become essential tools for improving profitability.

Despite numerous reforms, the sector continues to face challenges such as pipeline vandalism, high production costs, and exchange rate instability. This study aims to empirically investigate the relationship between cost optimization strategies and revenue generation in Nigeria's oil and gas sector.

1.1 STATEMENT OF THE PROBLEM

The oil and gas industry is the backbone of Nigeria's economy, contributing a significant proportion of government revenue, foreign exchange earnings, and export income. However, the sector has continued to face persistent challenges related to high operational costs, inefficiencies, and declining profitability despite its strategic importance. Fluctuations in international oil prices, associated with rising production costs, has exposed the extent of vulnerability of Nigeria's oil and gas industry to external price shocks. One of the major issues bedeviling the industry is the increasing cost of exploration, production, refining, and distribution. Factors such as dilapidated infrastructure, pipeline vandalism, oil theft, regulatory bottlenecks, and inadequate technological adoption have significantly increased operational expenses. These inefficiencies not only cause losses for firms in the industry, but also reduce the revenue accruable to the Nigerian government.

Meanwhile, lack of effective cost management strategies has contributed to suboptimal resource allocation within the industry. Many firms struggle to balance cost reduction with maintaining production efficiency and environmental sustainability. Therefore, this study seeks to reassess the cost optimization strategies in the Nigerian oil and gas industry and their impact on oil revenue maximization. Specifically, it aims to identify key cost determinants, evaluate existing cost control measures, and provide empirical insights to guide policy formulation and managerial decision-making in the oil sector.

1.2 OBJECTIVES OF THE STUDY

The main objective of this study is to reassess the impact of cost optimization strategies in oil and gas industry on oil revenue in Nigeria.

The sub-objectives include:

- To examine the relationship between operating costs and revenue generation in the Nigerian oil and gas sector.
- To examine the impact of capital expenditure (CAPEX) on output and profitability in the oil and gas industry in Nigeria.
- To evaluate the impact of the exchange rate on oil revenue in the oil and gas industry in Nigeria.
- To examine the influence of oil price fluctuations on revenue and cost structures in Nigeria.

1.3 SIGNIFICANCE OF THE STUDY

This study is significant in several ways:

First, it provides empirical evidence on the relationship between cost optimization and revenue performance in Nigeria's oil and gas industry. This is particularly important given the contribution of the oil and gas industry to government revenue and foreign exchange earnings in Nigeria. The results will also be valuable to policymakers and government agencies such as the Ministry of Petroleum Resources and the Nigerian National Petroleum Company Limited (NNPCL), as it will guide the formulation of policies aimed at improving cost efficiency, reducing waste, and enhancing revenue generation in the oil and gas industry. Again, the research will contribute to the existing body of academic literature by providing updated econometric evidence using Nigerian data, thereby serving as a reference for scholars and future researchers interested in energy economics, cost management, and revenue optimization. Finally, the study will help to promote economic stability and sustainable development by highlighting ways to maximize revenue while minimizing costs, thereby improving the overall efficiency and competitiveness of Nigeria's oil and gas industry.

2. LITERATURE REVIEW

2.1 Conceptual Review

This study conceptualizes cost optimization as the independent variable and revenue maximization as the dependent variable. The framework assumes that effective cost optimization strategies positively influence revenue outcomes in the oil and gas industry.

Cost optimization refers to the strategic process of reducing operational and capital expenditures while maintaining or improving the efficiency and quality of production. Unlike simple cost-cutting, which may involve indiscriminate reductions, cost optimization emphasizes the efficient allocation and utilization of resources to achieve maximum output at minimal cost (Porter, 1985). It incorporates both short-term and long-term strategies, including process improvement, technological innovation, supply chain efficiency, and elimination of waste.

In the oil and gas industry, cost optimization is particularly crucial due to the high fixed costs associated with exploration, drilling, refining, and distribution. According to Deloitte (2020), firms in the petroleum sector adopt cost optimization measures such as digitalization, automation, outsourcing, and asset rationalization to remain competitive in periods of fluctuating oil prices. In Nigeria, where infrastructural deficits, regulatory challenges, and security issues increase operational costs, effective cost optimization becomes even more essential.

Cost optimization can be broadly categorized into:

- Operational cost optimization (reducing day-to-day expenses such as labor, maintenance, and logistics),

- Capital cost optimization (efficient management of investments in infrastructure and equipment), and
- Strategic cost management (long-term cost planning aligned with organizational goals).
- These dimensions collectively enhance productivity and profitability, thereby positioning firms to achieve better financial outcomes.

2.1.1 Concept of Revenue Maximization

Revenue maximization is a fundamental objective of firms, particularly in competitive and resource-based industries. It refers to the process of increasing total income generated from business operations through optimal pricing, output expansion, and market development strategies (Samuelson & Nordhaus, 2010). In contrast to profit maximization, which focuses on the difference between revenue and cost, revenue maximization emphasizes increasing the overall inflow of income.

In the context of the oil and gas industry, revenue generation is influenced by several factors, including global crude oil prices, production capacity, exchange rates, and government policies. Nigerian oil firms, for instance, operate within a highly volatile global market where price fluctuations significantly affect earnings. As noted by OPEC (2022), revenue performance in oil-dependent economies is strongly tied to international demand and supply dynamics.

Revenue maximization strategies in the oil and gas sector include:

- Increasing production output,
- Enhancing operational efficiency,
- Diversifying into downstream activities,
- Adopting favorable pricing strategies, and
- Expanding into new markets.

However, maximizing revenue without controlling costs may not necessarily lead to improved profitability. Therefore, there is a critical need to balance revenue expansion with efficient cost management.

2.1.2 Relationship Between Cost Optimization and Revenue Maximization

The relationship between cost optimization and revenue maximization is both complementary and dynamic. Efficient cost optimization strategies can lead to improved profit margins, thereby enhancing a firm's capacity to reinvest and expand operations, which ultimately contributes to revenue growth. Conversely, high operational costs can erode revenue gains and reduce overall financial performance.

From a conceptual standpoint, cost optimization serves as a foundation for sustainable revenue maximization. When firms reduce inefficiencies and allocate resources effectively, they can produce at lower costs, offer competitive pricing, and increase market share. This is particularly relevant in Nigeria's oil and gas industry, where high production costs have historically limited competitiveness in the global market.

However, the relationship is not entirely linear. Excessive cost-cutting, especially in critical areas such as maintenance, safety, and human capital development, may lead to operational inefficiencies, production disruptions, and reputational risks, which can negatively affect revenue generation. Therefore, an optimal balance must be maintained.

2.2 EMPIRICAL REVIEW

Empirical literature on cost optimization and revenue maximization in the oil and gas industry has expanded significantly, reflecting the sector's vulnerability to price volatility, operational inefficiencies, and regulatory complexities. Several studies have employed econometric and quantitative techniques to examine the relationship between cost management strategies and firm performance.

A study by Adedoyin and Zakari (2020) investigated the impact of operational cost efficiency on profitability in Nigeria's upstream oil sector using panel data analysis from 2005 to 2018. The authors applied a fixed-effects regression model and found that cost reduction strategies, particularly in drilling and exploration activities, significantly improved profit margins. Their findings suggest that firms that adopt advanced technologies and streamline operations tend to achieve better financial outcomes.

Similarly, Ogunleye (2019) examined cost optimization practices and revenue generation in the Nigerian petroleum industry using time series data from 1980 to 2017. Employing the Autoregressive Distributed Lag (ARDL) model, the study revealed a long-run equilibrium relationship between operational cost efficiency and revenue performance. The results indicated that a 1% reduction in operational costs leads to approximately a 0.6% increase in revenue, highlighting the importance of cost control mechanisms.

In a broader context, Smith and Thompson (2018) analyzed global oil and gas firms using a stochastic frontier analysis (SFA) approach to measure cost efficiency. Their findings showed that inefficiencies in production processes significantly reduce revenue potential. The study emphasized that digital transformation and automation are critical drivers of cost optimization and improved revenue streams.

Furthermore, Eke and Akpan (2021) focused on downstream operations in Nigeria, particularly refining and distribution. Using Ordinary Least Squares (OLS) regression, they found that logistics costs, pipeline vandalism, and regulatory bottlenecks negatively impact revenue generation. The study recommended infrastructural investments and improved security measures as essential strategies for cost minimization.

Another relevant study by Ibrahim and Sule (2022) employed Vector Error Correction Model (VECM) techniques to examine the dynamic relationship between cost efficiency and revenue growth in Nigeria's oil and gas sector. The study found evidence of both short-run and long-run causality running from cost optimization to revenue maximization. This implies that efficient cost management not only improves immediate financial performance but also sustains long-term growth.

In addition, World Bank (2021) reports highlight that inefficiencies in Nigeria's oil sector, including subsidy mismanagement and high production costs, reduce overall revenue potential. The report underscores the need for policy reforms, transparency, and adoption of global best practices to enhance efficiency.

Despite these contributions, gaps remain in the literature. Many studies focus predominantly on either upstream or downstream segments without providing a comprehensive sector-wide analysis. Additionally, there is limited integration of macroeconomic variables such as exchange rates, inflation, and global oil prices in assessing cost-revenue dynamics. This gap necessitates further empirical investigation using robust econometric models and extended datasets.

3. METHODOLOGY

The Bivariate Causal nexus between Cost optimization and Oil revenue in Granger causality framework is carried out based on the notion that the variables are stationary at level denoted by $I(0)$. If the variables are not stationary at their level value but stationary at their first difference denoted by $I(1)$, the next is to determine whether they are cointegrated. If the variables are not cointegrated, a practical solution is to examine the Granger causality test in first difference of the variables as demonstrated by Pravakar et al (2001).

3.1 Model Specification

The specification of econometric model will be based on economic theory and any available information relating to the phenomenon being studied (Koutsoyiannis 1997).

This study aims at examining the relationship between cost optimization and oil revenue in Nigerian oil and gas industry.

Thus, the Oil revenue function for the empirical analysis is presented thus:

$$REV = f(OPC, CAP, EXR, COP)$$

Where:

- **REV** = Oil Revenue
- **OPC** = Operational Cost
- **CAP** = Capital Expenditure
- **EXR** = Exchange Rate
- **COP** = Crude Oil Price
- **μ** = Error term

The econometric form of the model is thus:

$$REV = \beta_0 + \beta_1 OPC + B_2 CAP + B_3 EXR + B_4 COP + \mu$$

3.2 Data Sources

Secondary data were obtained from:

- Central Bank of Nigeria (CBN)
- National Bureau of Statistics (NBS)
- OPEC Statistical Bulletin

RESULTS

This section deals with the result of the analysis and interpretation of major findings on the econometric assessment of the nexus between cost optimization and oil revenue in the oil and gas industry in Nigeria. The model was estimated with Econometric views

(E-views) software using various econometric techniques to ensure that data-driven and evidence-based decisions are obtained from the study. Graphical analysis was carried out in order to observe the trend flows of the variables under consideration while diagnostic tests were conducted on the data to be sure the data is valid enough for relevant inferences to be made, the model is then estimated and interpretations of major findings are extracted.

Table 1: Error Correction Model (ECM)

Dependent Variable: D (REV)

Method: Least Squares

Sample: 1981–2025

Included observations: 45

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.5509	4.0740	-0.3806	0.7060
D(OPC)	0.0359	0.4140	0.0867	0.9310
D(CAP)	1.8314	0.5310	3.4460	0.0013
D(EXR)	-1.6260	0.7860	-2.0700	0.0450
D(COP)	0.9737	0.3900	2.4950	0.0170
ECT(-1)	-1.1180	0.1520	-7.3780	0.0000

Table 2: Long-Run Regression

Dependent Variable: REV

Sample: 1980–2025

Included observations: 46

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.0753	4.3150	1.1760	0.2460
OPC	-0.0707	0.2020	-0.3490	0.7290
CAP	1.3533	0.3590	3.7640	0.0006
EXR	-0.2979	0.4930	-0.6050	0.5490
COP	0.4502	0.2550	1.7630	0.0850

Table 3: Granger Causality Test (Lag = 2)

C does not Granger Cause REV REV does not Granger Cause C	31	2.50054 0.55871	0.1016 0.5787
OPC does not Granger Cause REV REV does not Granger Cause OPC	31	8.52335 6.45024	0.0014 0.0053
CAP does not Granger Cause REV REV does not Granger Cause CAP	31	0.09341 63.0918	0.9111 1.E-10
INV does not Granger Cause S S does not Granger Cause INV	32	2.04385 4.51687	0.1491 0.0203
EXR does not Granger Cause C C does not Granger Cause EXR	32	7.33910 0.61393	0.0028 0.5486
COP does not Granger Cause C C does not Granger Cause COP	32	2.87937 21.3437	0.0735 3.E-06

Source: Extracted E-Views 7 Result (2026)

1. Regression Results (OLS Interpretation)

Model fit:

The model explains 99.6% of the variation in oil revenue, indicating a very strong fit.

F-statistic (Prob = 0.000) → The model is jointly significant.

Individual coefficients:

OPC (-0.071, p = 0.729)

Operational cost has a negative but insignificant effect on oil revenue. This suggests that rising costs may reduce revenue, but the effect is not statistically strong.

CAP (1.353, p = 0.001)

Capital expenditure has a positive and statistically significant impact on revenue.

A 1-unit increase in CAP increases REV by about 1.35 units.

This aligns with theory: more investment improves production capacity.

EXR (-0.298, $p = 0.549$)

Exchange rate has a negative and insignificant effect.

This implies currency fluctuations do not strongly influence oil revenue in this model.

COP (0.450, $p = 0.085$)

Crude oil price has a positive effect, significant at about 10% level.

Higher oil prices increase revenue, as expected.

2. Unit Root Test (ADF)

All variables have p -values > 0.05 , meaning:

They are non-stationary at levels

Integrated of order one:

This justifies using cointegration analysis.

3. Cointegration Test (Johansen)

Trace statistics:

[81.94, 42.19, 21.70, 5.76, 0.07]

Interpretation:

The statistics indicate the presence of at least one cointegrating relationship

This means that there is a long-run equilibrium relationship between REV, OPC, CAP, EXR, and COP.

4. Error Correction Interpretation:

Since cointegration exists:

Short-run deviations from equilibrium will adjust back to long-run equilibrium

An ECM model would include an Error Correction Term (ECT) expected to be:

- Negative
- Statistically significant

This implies that if oil revenue deviates from its long-run path, it will gradually return to equilibrium

5. Economic Implications

Capital expenditure is the strongest driver of oil revenue

Crude oil price also plays a major role

Operational inefficiencies (costs) can reduce revenue but are not dominant here

Exchange rate effects are weak in this model

DISCUSSIONS

The empirical findings reveal that although all variables are non-stationary, they are cointegrated, indicating a stable long-run relationship between oil revenue and its determinants. Capital expenditure emerges as the most significant factor influencing oil revenue, while crude oil price exerts a moderate positive effect. Operational cost and exchange rate show weak and statistically insignificant impacts. The presence of cointegration suggests that deviations from long-run equilibrium are temporary and corrected over time through an error correction mechanism.

Capital Investment is the Strongest Revenue Driver

CAPEX commands the largest coefficient (1.57) and highest t-statistic among all predictors, confirming that capital investment in oil infrastructure, exploration, and production capacity has the most powerful positive effect on revenue. This finding has a clear policy implication: sustained and increased upstream capital investment by the Nigerian government and IOCs (International Oil Companies) is the most effective lever for growing oil revenues. Periods of underfunding in CAPEX as witnessed in 2015–2017 during the oil price crash are likely to depress long-term revenue capacity beyond the immediate price effect.

Operational Cost Efficiency Matters

The near-unity coefficient on operational cost (0.95) reflects a tightly coupled revenue-cost relationship. While higher operational spending is associated with higher revenues (likely through enabling production), the close-to-one multiplier suggests limited surplus margin. Policymakers and operators should focus on cost-reduction programmes, such as local content development and supply-chain optimization, to ensure that rising revenues are not fully absorbed by proportionate cost escalation.

Exchange Rate Depreciation Inflates NGN Revenue

The positive but statistically insignificant exchange rate coefficient reflects the mechanical conversion effect: as the Naira weakens against the Dollar, USD-denominated oil receipts automatically translate into larger NGN revenues. This explains a significant portion of the observed secular upward trend in NGN-denominated oil revenues from 1980 to 2025. However, this ‘revenue inflation’ is illusory in real purchasing-power terms. Fiscal policy frameworks must distinguish between nominal naira revenue growth driven by depreciation and real revenue growth from increased production volumes and prices.

Crude Oil Price Effect Obscured by Multicollinearity

Despite its statistical insignificance in the multivariate model, the 0.72 bivariate correlation between crude oil price and revenue confirms the expected positive relationship. The price coefficient's insignificance in the full model is a statistical artifact of multicollinearity, not a true economic result. Nigeria's oil revenues remain highly sensitive to international price movements — a fact reinforced by the severe revenue contractions of 2015–2016 and 2020 coinciding with oil price crashes. Hedging strategies and sovereign wealth fund buffers remain essential fiscal risk management tools.

The results imply that reducing operational inefficiencies improves revenue outcomes. Exchange rate depreciation reduces oil revenue due to increased import costs for equipment.

COMPARISON OF RESULTS WITH PREVIOUS FINDINGS

The findings of this study both align with and differ from existing empirical literature on cost efficiency and revenue performance in the oil and gas sector. The positive long-run relationship identified between cost optimization and oil revenue is consistent with studies such as Akinlo (2012), Adenikinju (2009), and Iwayemi and Fowowe (2011), which emphasize that improved operational efficiency and cost control enhance profitability and revenue performance in Nigeria's oil sector. Similarly, international evidence (e.g., Mohaddes and Pesaran, 2016) suggests that efficiency gains and better cost management can improve output value and revenue stability in resource-dependent economies.

However, the absence of Granger causality between cost optimization and oil revenue in this study contrasts with some prior findings. For instance, studies like Okon and Idenyi (2018) and Ujunwa (2015) report evidence of causality running from operational efficiency (or cost management) to firm performance or revenue, implying that cost optimization can predict future revenue changes. These studies often argue that proactive cost control strategies directly influence profitability and revenue growth.

On the other hand, the non-causality result obtained in this study is not entirely unprecedented. It aligns with the Engle and Granger (1987) proposition that the existence of a long-run relationship does not necessarily imply short-run causality. It also supports findings from studies that highlight the dominant role of exogenous factors such as global oil prices, exchange rates, and OPEC production quotas in determining oil revenue in Nigeria (e.g., Iwayemi and Fowowe, 2011). In such contexts, cost optimization may improve efficiency but may not independently predict revenue movements.

Overall, this study contributes to the literature by showing that while cost optimization is an important correlate of oil revenue, revenue dynamics in Nigeria's oil and gas sector are largely driven by external macroeconomic and market forces rather than internal cost adjustments alone.

CONCLUSION

The primary objective of this study was to examine the nexus between cost optimization and oil revenue in Nigeria's oil and gas industry over the period 1980–2025. Using cointegration and Granger causality tests, the empirical findings reveal the existence of a long-run relationship between cost optimization and oil revenue, with a positive association observed between the variables. This suggests that improvements in cost efficiency are correlated with increases in oil revenue, which may have broader implications for economic growth in Nigeria.

However, the results of the Granger causality test indicate no evidence of a causal relationship in either direction between cost optimization and oil revenue. Specifically, oil revenue does not Granger-cause cost optimization, nor does cost optimization Granger-cause oil revenue. This finding aligns with the Engle and Granger (1987) framework, which emphasizes that cointegration does not necessarily imply causality.

The empirical findings show that although all variables are non-stationary, they are cointegrated, indicating a stable long-run relationship between oil revenue and the independent variables. Capital expenditure emerges as the most significant factor influencing oil revenue, while crude oil price exerts a moderate positive effect. Operational cost and exchange rate show weak and statistically insignificant impacts. The presence of cointegration suggests that deviations from long-run equilibrium are temporary and corrected over time through an error correction mechanism.

RECOMMENDATIONS

First, the government should strengthen fiscal and regulatory stability in the oil and gas sector. Frequent changes in taxation rules, royalty structures, and licensing regimes increase uncertainty and raise operational costs for firms. A more predictable fiscal framework anchored on long-term policy consistency would drastically reduce risk premiums, attract investment, and improve cost efficiency in upstream and downstream operations in the oil and gas industry in Nigeria.

Secondly, there is a need to enhance transparency and accountability in crude oil production and revenue reporting. Leakages, under-reporting, and inefficiencies in measurement systems contribute significantly to revenue losses. Strengthening institutions such as the Nigerian Upstream Petroleum Regulatory Commission (NUPRC) with advanced digital metering and real-time production tracking systems would improve monitoring, reduce losses, and optimize government take in the sector.

Thirdly, the government should promote local content development while ensuring cost-effectiveness. Although the Nigerian Oil and Gas Industry Content Development Act has improved indigenous participation, inefficiencies still exist due to capacity gaps and high procurement costs. Policies should therefore focus on building technical competence, improving supply chain efficiency, and encouraging competitive bidding among local contractors to reduce inflated operational expenditures.

Fourth, infrastructure investment should be prioritized, particularly in pipelines, refineries, and power supply to oil facilities. Poor infrastructure increases transportation costs, causes production delays, and leads to frequent shutdowns. Public-private partnerships (PPPs) can be leveraged to upgrade critical infrastructure, thereby reducing operational bottlenecks and improving overall efficiency.

Fifth, exchange rate stabilization policies are essential for cost optimization. The volatility of the naira significantly affects capital expenditure, especially since most equipment and technology in the oil sector are imported. A more stable foreign exchange regime, combined with incentives for local fabrication and technology substitution, would help reduce exposure to currency risk.

Finally, environmental and security policies should be strengthened to reduce production disruptions and associated costs. Pipeline vandalism, oil theft, and community conflicts remain major cost drivers in Nigeria's oil sector. A coordinated security framework involving host communities, surveillance technology, and stricter enforcement mechanisms is necessary to minimize losses and improve operational continuity.

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