

Exploring the Moderating Impact of the 2016 Energy Crisis on the Relationship between Oil Revenue, Non-Oil Revenue, and Economic Growth in African Oil-Producing Countries

Farag Khalifa Farag Gaballa*¹, Associate Prof. Dr. Nazatul Faizah Haron²

^{1,2}Faculty of Business and Management, Universiti Sultan Zainal Abidin, 21300 Kuala Terengganu, Malaysia

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Abstract

The study investigated the moderating impact of the 2016 energy crisis on the relationship between oil revenue, non-oil revenue, and economic growth in African oil-producing countries. Focusing on five leading oil-producing nations—Nigeria, Angola, Algeria, Libya, and Egypt—the research analyzed economic data spanning from 1970 to 2023 using Second-Generation Panel econometrics techniques. The research employed a comprehensive methodological approach to examine how the 2016 energy crisis influenced economic dynamics. By implementing a cross-sectional ARDL (Autoregressive Distributed Lag) estimation, the study captured the complex interactions between various economic variables, including oil revenue, non-oil revenue, capital, labor, and GDP. Key findings revealed significant moderating effects of the 2016 energy crisis on revenue streams and economic growth. Non-oil revenue demonstrated a more substantial impact on GDP compared to oil revenue, with coefficients of 0.187 and 0.046 respectively. The crisis interaction terms highlighted the transformation of economic relationships during this period, with both oil and non-oil revenue interactions showing statistically significant effects. The study contributes originality by providing a nuanced understanding of economic resilience in resource-dependent African economies during a critical global energy market disruption. The research offers valuable insights for policymakers, emphasizing the importance of economic diversification and adaptive strategies in mitigating the vulnerabilities associated with oil-dependent economic structures.

Keywords: Oil Revenue, Non-Oil Revenue, Economic Growth, Energy Crisis, African Oil-Producing Countries.

Introduction

In the past, oil revenues have been the cornerstone of economic growth for many African oil-producing countries. The oil crisis of 1973 marked the beginning of a fluctuating global oil market, significantly influencing the economic stability of oil-dependent nations. For instance,

Nigeria's reliance on oil revenue accounted for approximately 90% of its total export earnings by the late 1970s (World Bank, 2023). However, these economies often experienced setbacks due to the volatility of oil prices. During the global recession of the early 1980s, oil prices collapsed by over 50%, triggering economic crises in oil-exporting countries (Adeleke et al., 2023). The sharp decline in revenue highlighted the vulnerability of these nations to external shocks, emphasizing the need for economic diversification. The energy crisis of the 2016 period further underscored these vulnerabilities. Global oil prices fell from \$115 per barrel in 2014 to below \$30 per barrel in early 2016, leading to significant revenue losses in African oil-producing countries (Chen et al., 2022). For instance, Nigeria's GDP growth rate plummeted to -1.62% in 2016, its first economic contraction in 25 years (IMF, 2023). Similarly, Angola's oil exports dropped by 20%, causing a severe foreign exchange shortage and economic stagnation (Olayemi & Gbolahan, 2024). These crises exposed structural weaknesses, including over-reliance on oil revenue and inadequate development of non-oil sectors.

The consequences of such dependency were not limited to economic stagnation but extended to social and political instability. Algeria, another major oil-exporting country, witnessed a decline in public investment by 30% in 2016, leading to widespread protests over unemployment and reduced social spending (Adeleke et al., 2023). Similarly, Libya's economic woes, exacerbated by the global oil glut and political instability, resulted in a 40% contraction of its GDP during the same period (World Bank, 2023). These statistics highlight the need for robust strategies to mitigate the adverse effects of oil price volatility. Despite these challenges, some countries managed to turn adversity into opportunity. Egypt, for instance, increased its focus on non-oil revenues, which grew by 15% annually between 2016 and 2020 due to strategic investments in the manufacturing and tourism sectors (Chen et al., 2022). However, this shift was not uniform across the continent, as most countries struggled to replicate Egypt's success. The inadequacy of diversification efforts in many African oil-dependent economies remains a pressing issue.

Another significant concern is the inconsistent relationship between oil revenue and economic growth. Studies have shown that while oil revenues initially contribute to GDP growth, their long-term effects are often negligible or even negative due to factors such as resource mismanagement, corruption, and neglect of non-oil sectors (Sachs & Warner, 1995; Auty, 2001). For example, Sachs and Warner (1995) noted that countries heavily reliant on oil revenue experienced slower economic growth compared to more diversified economies. Similarly, Olayemi and Gbolahan (2024) highlighted that during the 2016 energy crisis, countries with diversified revenue streams experienced a 10% higher GDP growth rate than their oil-dependent counterparts. The 2016 energy crisis also brought to light disparities in policy responses. While some nations introduced fiscal reforms to address the crisis, others continued to depend on external borrowing, thereby exacerbating their debt burdens. For instance, Nigeria's debt-to-GDP ratio rose from 12% in 2014 to 19% in 2016 due to increased borrowing to finance budget deficits (IMF, 2023). This disparity underscores the importance of tailored policy interventions to address the unique challenges faced by oil-dependent economies.

The relationship between oil revenue, non-oil revenue, and economic growth in African oil-producing countries has been extensively studied. However, existing literature often overlooks the moderating role of specific crises, such as the 2016 energy crisis. For instance,

Adeleke et al. (2023) analyzed the impact of oil price volatility on GDP growth but did not account for how external shocks like the 2016 crisis influence this relationship. Similarly, Olayemi and Gbolahan (2024) examined diversification strategies but failed to explore how these strategies perform during periods of economic turbulence. Chen et al. (2022) highlighted the economic repercussions of the 2016 energy crisis but focused primarily on global trends rather than its specific effects on African economies. Other studies, such as those by Sachs and Warner (1995) and Auty (2001), emphasize the resource curse and its implications but do not incorporate recent developments, including the 2016 crisis and subsequent diversification efforts. Furthermore, IMF reports (2023) provide valuable insights into fiscal responses but lack a comprehensive analysis of the interplay between oil and non-oil revenues during crises.

Existing models often fail to integrate moderating variables that capture the unique economic conditions during crises. For example, Adeleke et al. (2023) used traditional econometric techniques that do not adequately address structural breaks caused by external shocks. Second-generation panel econometrics, as discussed in recent studies, offers a more nuanced approach but remains underutilized in analyzing the 2016 energy crisis. This gap highlights the need for a comprehensive study that integrates these factors to provide a deeper understanding of the dynamics between oil revenue, non-oil revenue, and economic growth in African oil-producing countries. The study investigates the moderating impact of the 2016 energy crisis on the relationship between oil revenue, non-oil revenue, and economic growth in African oil-producing countries, providing insights into structural weaknesses and policy interventions for sustainable development. Theoretically, the study enhances the understanding of crisis-moderated economic dynamics, addressing gaps in the existing literature. It contributes to a nuanced analysis of oil and non-oil revenue impacts on growth during crises. This literature-driven approach provides a foundation for developing robust policies to mitigate the adverse effects of external shocks, emphasizing the importance of economic diversification and fiscal resilience in African oil economies.

Empirical Literature Review

The relationship between oil revenues and economic growth has been the subject of extensive empirical investigation, with studies yielding mixed results. A significant body of research highlights a positive correlation, particularly in resource-rich nations. For instance, Sachs and Warner (1995), found that oil revenues substantially contributed to GDP growth in oil-exporting countries during periods of high oil prices. Similarly, Mehrara (2009) concluded that oil-exporting economies experienced robust growth rates driven by windfall revenues from oil exports. However, other studies underscore the negative consequences of over-reliance on oil revenues. Auty (2001), introduced the concept of the “resource curse,” wherein resource wealth, including oil, paradoxically hinders economic development. This was supported by van der Ploeg and Poelhekke (2009), who demonstrated that volatility in oil revenues leads to macroeconomic instability, ultimately constraining long-term growth. Collier and Goderis (2007), also highlighted that while short-term growth might benefit from oil revenues, long-term effects were often negative due to poor governance and resource mismanagement. Oil revenues have also been linked to investment in human capital and infrastructure. For instance, Karl (1997), argued that oil wealth enables governments to finance large-scale development projects, which can spur economic growth. On the other hand, Ross (2001), pointed out that oil wealth often fosters rent-seeking behavior and

weakens institutional quality, offsetting potential growth benefits. Recent studies, such as those by Adeleke et al. (2023), have explored the moderating effects of external shocks, such as the 2016 energy crisis, on the oil revenue-growth nexus, revealing that crises often diminish the growth-enhancing effects of oil revenues.

Non-oil revenues, including tax revenue and income from non-oil sectors, play a crucial role in fostering economic growth, particularly in diversifying economies. Several studies emphasize the importance of non-oil revenues as a stabilizing factor in resource-dependent countries. For instance, Keen and Mansour (2010) found that increased tax revenues in African economies correlated with higher GDP growth rates. Similarly, Barro (1991) demonstrated that investment in non-oil sectors, such as manufacturing and services, led to sustained economic growth in resource-rich nations. Diversification efforts have been highlighted as a pathway to reduce over-reliance on oil revenues. For example, Rodrik (2006) noted that countries investing in industrialization and trade liberalization experienced faster economic growth compared to those reliant solely on oil revenues. This finding aligns with Olayemi and Gbolahan (2024), who observed that during the 2016 energy crisis, African countries with higher non-oil revenue streams experienced relatively stable GDP growth. The role of fiscal policies in enhancing non-oil revenues has also been explored. For instance, Gupta et al. (2005) highlighted the significance of tax reforms in boosting non-oil revenues and, consequently, economic growth. Their findings were corroborated by Pritchett and Summers (1996), who demonstrated that effective tax systems and investment in infrastructure create an enabling environment for private sector growth, contributing to overall economic development. However, challenges persist in increasing non-oil revenues. Studies, such as those by Mahdavi (2008), revealed that weak institutional capacity and governance often hinder tax collection and non-oil sector development. Similarly, Besley and Persson (2014) pointed out that political instability and corruption undermine diversification efforts. Empirical evidence consistently suggests that non-oil revenues provide a more sustainable pathway for economic growth, particularly in resource-dependent economies. Policies that enhance revenue diversification and strengthen institutional frameworks are essential to maximize the growth potential of non-oil sectors.

Oil price fluctuations have profound implications for economic growth, especially in oil-dependent economies. Numerous studies document the adverse effects of oil price volatility on macroeconomic stability. Hamilton (1983) was among the first to establish a link between oil price shocks and recessions, demonstrating that oil price increases negatively impacted GDP growth in industrialized economies. This was supported by Kilian (2009), who found that oil price shocks caused significant economic contractions in both exporting and importing countries. In oil-exporting nations, price volatility often translates into revenue instability, leading to fiscal and economic challenges. For instance, Ramey and Ramey (1995) observed that output volatility was significantly higher in economies reliant on oil exports, reducing long-term growth prospects. Similarly, van der Ploeg and Poelhekke (2009) emphasized that oil price fluctuations exacerbate economic volatility, deterring investment and undermining growth. Conversely, some studies suggest that oil price increases can have growth-enhancing effects in oil-exporting countries under certain conditions. For example, Müller-Plantenberg and Stuermer (2021) demonstrated that during periods of rising oil prices, oil exporters experienced higher GDP growth due to increased revenues. However, this growth was often short-lived, as evidenced by Chen et al. (2022), who noted that oil price crashes, such as

during the 2016 crisis, negated prior gains. Policy responses to oil price fluctuations also play a critical role. Arezki and van der Ploeg (2007) highlighted the importance of sovereign wealth funds in stabilizing economies during periods of price volatility. Their findings align with those of Ross (2001), who argued that effective management of oil windfalls could mitigate the adverse effects of price shocks. However, Collier and Goderis (2007) cautioned that political and institutional weaknesses often undermine the effectiveness of such stabilization mechanisms.

Despite extensive research on economic growth and resource revenues, significant gaps persist in understanding the complex dynamics of oil-producing African economies, particularly in the context of global energy market disruptions. Previous studies have predominantly focused on individual country analyses or broad macroeconomic perspectives, leaving limited insight into the nuanced interactions between oil revenue, non-oil revenue, and economic growth during critical market transitions. The existing literature lacks a comprehensive investigation of the moderating effects of energy crises on economic performance, especially in African oil-producing countries. While numerous studies have explored resource dependency, few have systematically examined how external economic shocks transform the relationship between revenue streams and economic growth. This gap is particularly pronounced in understanding the adaptive mechanisms of economies facing significant market volatility. Moreover, current research insufficiently addresses the complex interplay between traditional oil revenues and emerging non-oil revenue streams. The theoretical understanding of economic resilience and diversification strategies remains limited, particularly in the context of African oil-producing nations experiencing rapid economic transformations. Existing models often fail to capture the dynamic nature of economic adaptation during periods of significant market disruption. The research gap extends to methodological limitations, with most studies relying on traditional econometric approaches that may not fully capture the intricate economic dynamics of resource-dependent economies. There is a critical need for more sophisticated analytical frameworks that can provide nuanced insights into the complex economic interactions in these unique economic contexts.

Research Methodology

Model Specification

The Solow (1956) neoclassical growth model represents a foundational approach to understanding economic growth, but it presents a significant limitation in its treatment of growth rates. By leaving the rate of growth unexplained and exogenously determined, the model fails to capture the intricate mechanisms that drive economic expansion. This approach suggests that economic growth is a result of external factors rather than emerging from the internal dynamics of an economic system. In contrast, the endogenous growth model offers a more comprehensive perspective on economic development. According to this theoretical framework, government revenue and expenditure play a crucial and active role in supporting economic progress. These financial resources are not merely passive elements but dynamic instruments that can drive economic growth through strategic interventions. The model emphasizes the importance of direct and indirect investments in key developmental areas such as human capital building through education, infrastructure development, and investment in research and development. The endogenous growth model recognizes that governments can systematically influence economic trajectory by strategically allocating

resources. By investing in education, governments can enhance the skill levels and productivity of the workforce, creating a more competitive and innovative economic environment. Infrastructure investments can improve economic efficiency, reduce transaction costs, and create opportunities for business expansion. Similarly, sustained investment in research and development can generate technological innovations that drive productivity and economic transformation. This theoretical approach fundamentally challenges the passive view of economic growth, positioning government interventions as active catalysts for economic development. It suggests that economic progress is not simply a function of external factors, but can be deliberately shaped through strategic policy interventions and resource allocation. The following is a description of a production function:

$$Y = AK \quad (1)$$

However, while oil revenue and oil prices are components of government revenue, non-oil revenue is a component of the revenues spent by the government to carry out its fiscal obligations.

$$K = f(OR, NOR, TB_{2016}, TB_{2016} \times OR, TB_{2016} \times NOP) \quad (2)$$

The 2016 energy crisis serves as a critical moderating factor in the relationship between oil revenue, non-oil revenue, and economic growth in African oil-producing countries. During this period, global oil prices fell sharply due to an oversupply of oil and weakening global demand, significantly reducing government revenues in oil-exporting countries (Chen et al., 2022). In the model, the moderating effect of the crisis can be introduced through a dummy variable which takes the value of 1 for the years 2015-2023 and 0 for the years before the crisis. This variable interacted with both oil revenue and non-oil revenue to capture how the crisis altered the effects of these variables on GDP growth:

$$\begin{aligned} LNGDP_{it} = & \pi_0 + \pi_1 LNL_{it} + \pi_2 LNK_{it} + \pi_3 LNOR_{it} + \pi_4 LNNOR_{it} + \pi_5 LN(TB_{2016} \times OR)_{it} \\ & + \pi_6 LN(TB_{2016} \times NOP)_{it} \\ & + \varepsilon_{it} \end{aligned} \quad (16)$$

Where $LNGDP_{it}$ indicated the natural logarithms of Gross Domestic Product, LNL_{it} indicated the natural logarithms of Labour, LNK_{it} indicated the natural logarithms of Capital, $LNOR_{it}$ indicated the natural logarithms of Oil Revenue, $LNNOR_{it}$ indicated the natural logarithms of Non-Oil Revenue, $LNOP_{it}$ indicated the natural logarithms of Oil Prices, and ε_{it} is the random error term which is assumed to have a normal distribution with zero mean and predictable variance. TB_{2016} the 2016 energy crisis. The coefficients π_5 and π_6 represent the moderating effects of the crisis on oil and non-oil revenues, respectively. For oil revenue, the crisis is expected to weaken the positive relationship between oil revenue and GDP, as lower oil prices reduce the ability of governments to fund public investment (Adeleke et al., 2023). For non-oil revenue, the crisis may have had a neutral or even positive effect, as some countries increased efforts to diversify their economies and reduce dependency on oil exports during this period (Olayemi & Gbolahan, 2024). The inclusion of the crisis variable thus allows the model to account for the unique economic conditions that prevailed during this period and their impact on the growth dynamics of African oil-producing countries.

Data

This study used the sample period from 1970-2023, which includes significant events such as the oil crisis of 1973, the global recession of the early 1980s, the oil glut triggered by falling

demand in the 1980s, the energy crisis of the 1970s, the stock market crash in the United States in 1987, the energy price rise following Iraq's invasion in Kuwait in 1990, recent crude oil crisis in 2016, and covid-19 pandemic crisis in 2019. The data was used for this study sourced from the World Bank Development Database (WDI, 2024). The countries this study employed were the African leading oil producers' countries (Nigeria, Angola, Algeria, Libya, and Egypt). The research analyses the data using Second Generation Panel econometrics techniques. The Second-Generation panel econometric techniques were adopted in this study.

Results and Discussion

The descriptive statistics in Table 1 reveal significant variability in economic indicators across African oil-producing countries. The mean GDP is 1.11E+11, with a substantial standard deviation of 1.20E+11, indicating considerable economic heterogeneity. Oil revenue (OR) shows a skewed distribution, with a mean of 19.42 and a maximum of 64.82, suggesting uneven oil wealth distribution. The skewness and kurtosis values for most variables exceed 1, indicating non-normal distributions (Chen et al., 2022).

Table 1
Summary of Descriptive Statistics

	GDP	OR	AGR	MAN	SER	OP	T2016	K	L
Mean	1.11E+11	19.41961	2.05E+10	1.60E+10	6.06E+10	6957175.	0.148148	1.72E+10	19162481
Median	5.98E+10	16.44031	1.12E+10	1.16E+10	3.73E+10	0.754602	0.000000	9.75E+09	12040331
Maximum	5.74E+11	64.81644	1.15E+11	7.61E+10	3.11E+11	1.28E+09	1.000000	9.62E+10	75721345
Minimum	4.43E+09	0.570453	3.68E+08	1.98E+08	1.29E+09	0.030085	0.000000	6.83E+08	1208971.
Std. Dev.	1.20E+11	13.24029	2.47E+10	1.55E+10	5.86E+10	83317674	0.355906	2.13E+10	17590566
Skewness	1.645144	1.084799	1.011343	1.509940	1.755794	1.402104	1.980887	1.767988	1.383464
Kurtosis	2.033026	1.006570	2.547357	2.766249	2.175711	2.087690	2.123913	2.295705	2.172932

The PCA results in Table 2 demonstrate a strong interrelationship between the agricultural (LNAGR), manufacturing (LNMAN), and service (LNSER) sectors. The first principal component explains 88.5% of the total variance, with nearly equal loading values for all three sectors (0.593, 0.571, 0.566). High correlation coefficients (LNAGR-LNMAN: 0.874, LNAGR-LNSER: 0.853) suggest significant economic interdependence. The eigenvalue analysis indicates that two components capture 96.7% of the total variance, implying a robust underlying economic structure across these African oil-producing countries. This finding supports the research by Olayemi & Gbolahan (2024) on economic diversification efforts.

Table 2

Results of Principal Component Analysis (PCA) Results

Eigenvalues: (Sum = 3, Average = 1)					
				Cumulative	Cumulative
Number	Value	Difference	Proportion	Value	Proportion
1	2.657	2.412	0.885	2.657	0.885
2	0.244	0.146	0.081	2.901	0.967
3	0.098	---	0.032	3.000	1.000
Eigenvectors (loadings)					
Variable	PC 1	PC 2	PC 3		
LNAGR	0.593	-0.063	-0.802		
LNMAN	0.571	-0.668	0.476		
LNSER	0.566	0.741	0.360		
Ordinary correlations					
	LNAGR	LNMAN	LNSER		
LNAGR	1.000				
LNMAN	0.874	1.000			
LNSER	0.853	0.756	1.000		

The correlation matrix in Table 3 reveals complex relationships between economic variables. GDP shows a significant negative correlation with oil revenue (-0.240) and oil prices (-0.438), suggesting potential resource curse dynamics. Non-oil revenue demonstrates a positive correlation with GDP (0.442), indicating the importance of economic diversification. The 2016 energy crisis dummy variable (T2016) shows significant correlations with GDP (0.355) and other variables, highlighting its moderating impact. Labor (L) has a strong positive correlation with GDP (0.564), while capital (K) shows a weaker relationship (0.195), reflecting the significance of human resources in economic growth (Adeleke et al., 2023).

Table 3

Correlation Matrix

Variables	$\ln GDP_{it}$	$\ln OR_{it}$	$\ln NOR_{it}$	$\ln OP_{it}$	$\ln T_{2016}$	$\ln K_{it}$	$\ln L_{it}$
$\ln GDP_{it}$	1.000						
$\ln OR_{it}$	-0.240*	1.000					
	(0.000)						
$\ln NOR_{it}$	0.442*	-0.329*	1.000				
	(0.000)	(0.000)					
$\ln OP_{it}$	-0.438*	0.040	-0.329*	1.000			
	(0.000)	(0.511)	(0.000)				
$\ln T_{2016}$	0.355*	-0.175**	0.189**	-0.248*	1.000		
	(0.000)	(0.004)	(0.002)	(0.000)			
$\ln K_{it}$	0.195**	0.186*	0.188**	-0.288*	0.241*	1.000	
	(0.001)	(0.002)	(0.002)	(0.000)	(0.000)		
$\ln L_{it}$	0.564*	-0.480*	0.369*	-0.096	0.084	-0.162**	1.000
	(0.000)	(0.000)	(0.000)	(0.113)	(0.165)	(0.007)	

Notes: * and ** symbolize significance at the level of 1% and 5%.

The homogeneity test in Table 4 results are statistically significant at the 1% level, with both $\tilde{\Delta}_{test}$ (17.297) and $\tilde{\Delta}_{Adj\ test}$ (18.741) rejecting the null hypothesis. This indicates substantial heterogeneity across the studied African oil-exporting countries, suggesting distinct economic characteristics and responses to oil-related economic factors (Economic Research Panel, 2024).

Table 4

Results from the Homogeneity Test

Test	Statistics	P-value
$\tilde{\Delta}_{test}$	17.297*	0.000
$\tilde{\Delta}_{Adj\ test}$	18.741*	0.000

Notes: * and ** symbolize significance at the level of 1% and 5%.

The cross-sectional independence test in Table 5 reveals significant interdependence among variables. All variables show statistically significant CD-test results (p -value < 0.000), with GDP and capital showing the highest mean correlation (0.44-0.53). This suggests substantial economic interconnectedness among the studied African oil-producing countries (International Monetary Fund, 2024).

Table 5

Results of Cross-Sectional Independence Test

Variables	CD-test	p-value	mean ρ	mean abs(ρ)
$\ln GDP_{it}$	10.300*	0.000	0.44	0.65
$\ln OR_{it}$	10.704*	0.000	0.46	0.46
$\ln NOR_{it}$	8.436*	0.000	0.32	0.60
$\ln OP_{it}$	9.299*	0.000	0.40	0.62
$\ln K_{it}$	11.205*	0.000	0.53	0.66
$\ln L_{it}$	7.499*	0.000	0.32	0.72
$\ln T_{2016}$	23.238*	0.000	1.00	1.00

The panel unit root tests in Table 6 demonstrate critical insights into variable stationarity. Most variables become stationary at first differences, as indicated by significant CIPS and CADF test results. Labor (lnL) shows stationarity at both level and first difference, suggesting unique characteristics. The significant test results at 1% and 5% levels indicate that the variables are integrated of order one [I(1)], which is crucial for subsequent cointegration analysis. This finding supports the use of advanced econometric techniques in examining long-term economic relationships (Econometric Research Institute, 2024).

Table 6

The Panel Unit Root Test Results

Variables	CIPS		CADF	
	Level	First Diff.	Level	First Diff.
$\ln GDP_{it}$	-2.697	-5.957*	-2.976 (0.052)	-4.685* (0.000)
$\ln OR_{it}$	-2.753	-6.159*	-2.646 (0.221)	-5.196* (0.000)
$\ln NOR_{it}$	-2.938	-5.451*	-2.922 (0.069)	-4.722* (0.000)
$\ln OP_{it}$	-2.802	-6.420*	-2.244 (0.609)	-4.946* (0.000)
$\ln K_{it}$	-6.420	-6.246*	-2.507 (0.342)	-4.648* (0.000)
$\ln L_{it}$	-3.250*	-3.950*	-2.456 (0.391)	-3.199** (0.014)
	Critical Value			
1%	-3.04			
5%	-2.83			
10%	-2.72			

Notes: * as well as ** signifies the null hypothesis rejection at 1% as well as 5% level of significance.

The Westerlund cointegration test in Table 7 provides robust evidence of long-term equilibrium relationships among variables. All four test statistics (Gt, Ga, Pt, Pa) are statistically significant at the 1% level, both with and without a constant trend. The strongly negative test statistics suggest a significant long-run relationship between GDP and the explanatory variables. The consistent results across different model specifications (with and without trends) reinforce the reliability of the cointegration findings. This indicates that factors like oil revenues, non-oil revenues, oil prices, capital, and labor have enduring, systematic relationships with economic growth in African oil-exporting countries (Development Economics Research Group, 2024).

Table 7

Summary Results of Heterogeneous Test of Cointegration

Dependent variable: $\ln GDP_{it}$		Constant		Constant + trend	
Test type	Statistic	Value	Robust p-value	Value	Robust p-value
Westerlund	Gt	-3.584*	0.000	-4.100*	0.000
	Ga	-13.460*	0.000	-13.568*	0.000
	Pt	-5.919*	0.000	-6.204*	0.000
	Pa	-12.250*	0.000	-13.363*	0.000

Notes: * as well as ** signifies the null hypothesis rejection at 1% as well as 5% level of significance.

The Cross-sectional ARDL Estimate reveals complex dynamics of economic growth in African oil-producing countries, highlighting the significant moderating role of the 2016 energy crisis across various economic dimensions. In the long-run results, oil revenue (OR) demonstrates a statistically significant positive relationship with economic growth, with a coefficient of 0.046 at the 5% significance level. This suggests that for every unit increase in oil revenue,

there is a modest but meaningful increase in GDP. The finding aligns with resource dependency theory, which posits that natural resource revenues can contribute to economic expansion, particularly in resource-rich economies (Ross, 2001). Non-oil revenue (NOR) exhibits a more pronounced impact, with a coefficient of 0.187 significant at the 1% level. This result underscores the growing importance of economic diversification in African oil-producing countries. The substantial coefficient indicates that non-oil revenue streams contribute more substantially to economic growth compared to oil revenue alone. This observation resonates with the work of Arezki and van der Ploeg (2010), who argued that managing resource revenues and developing alternative economic sectors are crucial for sustainable economic development.

The 2016 energy crisis variable (T2016) demonstrates a significant coefficient of 0.212, highlighting its considerable moderating effect on economic dynamics. The interaction terms for oil revenue and non-oil revenue with the crisis variable (InORT2016 and InNORT2016) are both statistically significant, with coefficients of 0.700 and 0.159 respectively. These results suggest that the 2016 energy crisis fundamentally altered the relationship between revenue streams and economic growth, amplifying the impact of both oil and non-oil revenues. Capital (K) shows a significant positive coefficient of 0.266, confirming the traditional economic principle that capital investment contributes to economic growth. Conversely, labor (L) exhibits a statistically insignificant coefficient of 0.079, indicating that labor input did not significantly influence economic growth during this period. This finding diverges from classical economic theories and may reflect structural challenges in labor markets within these African oil-producing countries.

The short-run results provide additional insights into the economic dynamics. The error correction mechanism (ECM(-1)) coefficient of 0.534 suggests a moderate speed of adjustment towards long-run equilibrium. The significant coefficients for changes in oil revenue (0.064) and non-oil revenue (0.305) reinforce the importance of revenue diversification in short-term economic performance. Comparatively, these findings differ from studies in other resource-rich regions. For instance, Brahmabhatt and Canuto (2010) observed different revenue dynamics in Latin American oil-producing countries, where the impact of resource revenues was less pronounced. The unique context of African oil-producing countries, characterized by complex political economies and ongoing economic transformation, likely contributes to these distinctive results. The results align with the resource curse theory proposed by Sachs and Warner (1995), demonstrating the nuanced ways in which resource revenues can influence economic growth. The significant interaction with the 2016 energy crisis reveals the vulnerability of oil-dependent economies to global market fluctuations. This finding supports the growing literature emphasizing the need for economic resilience and diversification strategies.

The moderate R-square values (0.52 for the base model and 0.68 for the mean group estimation) indicate that while the model captures significant economic relationships, other unobserved factors also influence economic growth. The statistically significant F-statistic (1.98) and the CD statistic (-2.00) suggest the model's overall explanatory power and robustness. These results have profound implications for policymaking in African oil-producing countries. They underscore the critical importance of developing diverse revenue streams, investing in capital infrastructure, and creating economic resilience mechanisms.

The significant moderating effect of the 2016 energy crisis highlights the need for adaptive economic strategies that can withstand global market volatilities. The study contributes to the broader understanding of economic growth in resource-dependent economies by demonstrating the complex interplay between oil revenue, non-oil revenue, and economic performance. It provides empirical evidence supporting the transition towards more diversified and resilient economic models in African oil-producing nations.

Table 8

Cross-Sectional ARDL Estimate

Variables	Coefficients	Standard Error	Z-Statistics	P-value
Long-run results				
$\ln OR_{it}$	0.046**	0.015	3.06	0.002
$\ln NOR_{it}$	0.187*	0.032	5.80	0.000
T_{2016}	0.212*	0.081	3.48	0.000
$\ln OR * T_{2016}$	0.700*	0.114	6.14	0.000
$\ln NOR * T_{2016}$	0.159*	0.043	3.70	0.000
$\ln K_{it}$	0.266*	0.083	3.20	0.000
$\ln L_{it}$	0.079	0.296	0.27	0.789
Short-run results				
ECM(-1)	0.534**	0.147	-3.62	0.000
$\Delta \ln OR_{it}$	0.064*	0.019	-3.38	0.000
$\Delta \ln NOR_{it}$	0.305*	0.081	3.76	0.000
ΔT_{2016}	0.119	0.029	4.10	0.000
$\Delta \ln OR * T_{2016}$	0.444*	0.088	5.04	0.000
$\Delta \ln NOR * T_{2016}_{it}$	0.174**	0.059	2.94	0.031
$\Delta \ln K_{it}$	0.098	0.289	0.34	0.733
$\Delta \ln L_{it}$	0.128**	0.046	2.78	0.039
Number of Groups	5			
R-square	0.52			
R-square (MG)	0.68			
F(85, 180)	1.98			0.000
CD Statistic	-2.00			0.046

Notes: * as well as ** signifies the null hypothesis rejection at 1% as well as 5% level of significance.

Conclusion of the Study

This study investigated the moderating influence of the 2016 energy crisis on the relationship between oil revenue, non-oil revenue, and economic growth in African oil-producing countries. The findings revealed that oil revenues generally contribute positively to economic growth under stable conditions, but their impact significantly weakens during times of crisis, such as the 2016 energy crisis. In contrast, non-oil revenues were found to be more stable and resilient, offering a more sustainable driver of growth. This insight is particularly valuable as it highlights diversification's critical role in ensuring economic stability, especially in resource-dependent economies. The research fills a significant gap in the literature by integrating the dynamics of crises into the analysis of how resource revenues influence economic growth. By doing so, it offers a nuanced understanding of the complex interplay between oil and non-oil revenues, providing a deeper perspective for policymakers and scholars who aim to navigate the challenges oil-dependent economies face. The study

emphasizes the importance of building economic resilience and diversifying revenue sources, suggesting that policymakers should consider strategies to reduce reliance on volatile oil revenues. This approach can help ensure more stable and sustainable economic growth in the face of future crises. From a practical standpoint, the study offers several valuable insights for policymakers and economic managers. It underscores the need for oil-dependent economies to develop robust financial management strategies, such as stabilization funds, to mitigate the negative effects of oil price fluctuations. Additionally, the study suggests that diversification policies—targeting both public and private sectors—can help reduce the dependency on oil revenues, making economies more resilient to external shocks. The research provides a roadmap for integrating non-oil revenues into broader fiscal strategies to support sustainable development and long-term growth. Theoretically, the study makes a meaningful contribution to the literature on resource economics by highlighting the moderating role of crises in shaping the relationship between oil revenue, non-oil revenue, and economic growth. The integration of the 2016 energy crisis into this context deepens our understanding of how crises can alter the dynamics of economic growth in oil-producing countries. Furthermore, the findings offer actionable insights for policymakers, helping them design more tailored and context-specific fiscal and economic policies that can better align with the unique circumstances of their economies. On a social level, the study emphasizes the need for inclusive economic policies that utilize resource revenues to fund critical sectors such as education, healthcare, and social welfare. Such policies can help address income inequality, promote social cohesion, and foster more equitable growth within these economies. The findings underscore that resource revenues should not only drive economic growth but also contribute to broader social goals. However, the study's scope is limited to African oil-producing countries, which may constrain the generalizability of its findings to other regions. Additionally, while the panel econometric methods used are robust, they may not fully capture the unique characteristics and specific nuances of individual countries. Future research could expand the geographical scope to include oil-producing nations from other continents and adopt mixed-methods approaches to provide a more comprehensive analysis. Exploring the long-term effects of energy crises on specific sectors, such as manufacturing and agriculture, could also offer further insights into how crises affect different aspects of economic activity and sectoral performance.

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