

ENERGY CONSUMPTION AND ECONOMIC GROWTH IN AFRICA: EXAMINING THE INFLUENCE OF INCOME LEVEL AND OIL PRODUCTION

Ololade Mistura AROMASODUN¹, Musa Ilias BIALA¹, Abdul Muftah SHITU¹

DOI: 10. 2478/tjeb-2025-0009

This study investigates how oil production and income levels influence the relationship between energy consumption and economic growth across the 54 African countries over the period 1996 to 2022. Employing the Random Effects Method—validated through the Hausman Test—the analysis explores both the direct and interactive (moderating) roles of income and oil production. The findings reveal that income level significantly impacts economic growth in two ways: directly and by strengthening the positive effect of energy consumption on growth. This dual influence underscores the critical role of income as both a catalyst for economic expansion and a key factor in shaping the energy-growth relationship. In contrast, oil production demonstrates neither a statistically significant independent effect nor a moderating influence on the energy-growth nexus. This outcome suggests that, despite the prominence of oil in many African economies, its role in fostering broad-based economic growth through energy consumption may be limited or context dependent. The results emphasize the importance of tailoring energy and development policies to reflect the varying income dynamics among African nations. By prioritizing income-sensitive strategies, policymakers can better support sustainable economic growth while effectively managing the region's diverse energy demands and development challenges especially in resource-constrained and fossil-fuel-dependent economies.

Keywords: Income level; Oil production; Economic growth; Energy consumption; Africa

JEL Classification: O15; Q43; O40; Q41; O55

^{1, 2, 3} Lecturer, Kwara State University, Malete, Nigeria

AROMASODUN, O. M., BIALA, M. I., & SHITU, A. M. (2025)*Energy consumption and economic growth in Africa: examining the influence of income level and oil production*

1. Introduction

Although the growth of modern industries like manufacturing, motorized transportation, and urban areas is directly linked to rising energy consumption in developing nations. Energy consumption is also associated with geography, climate, and the economy (e.g., relative energy prices). Nevertheless, even though energy consumption has been rapidly rising across all three income groups, high-income nations still consume about five times as much energy per person as low- and middle-income economies (International Energy Agency [IEA], 2022).

Africa has an extremely varied energy environment, with different nations producing and consuming energy at different rates. Many African nations continue to have significant rates of poverty and income inequality, which might restrict access to modern energy services, according to the World Bank (2020a). But there are also other instances of nations that have significantly improved energy availability, like Mauritius, which has a high rate of electrification and a varied energy mix.

Higher income nations, like Gabon and Equatorial Guinea, often have a more varied energy mix and use a larger proportion of oil and petroleum products overall. For instance, Gabon's primary energy supply was 6,220 ktoe in 2018. Of that amount, 84% came from biomass, 12% from oil and petroleum products, and 4% from electricity (African Energy Commission [AFREC], 2020).

Conversely, lower-income nations like Ethiopia and Rwanda mostly rely on traditional biomass, such firewood and charcoal, for their energy needs. 92% of Rwanda's ultimate consumption came from biomass, the majority of which was utilized in domestic settings. Likewise, in Ethiopia, 85% of the country's energy consumption in 2018 came from biomass (AFREC, 2020).

In terms of oil production, Angola, Nigeria, and Algeria are among the biggest oil-producing nations in Africa. For instance, Angola produced 69,366 ktoe of crude oil in 2018, of which 93.5% was exported. In 2018, the nation's total primary energy supply was 10,953 ktoe, with the principal sources of electricity generation being fossil thermal and hydropower (AFREC, 2020). The commission also points out that there is a lot of opportunities for renewable energy growth on the continent, especially in the fields of hydro, wind, and solar energy.

Despite the expanding database of research on the connection between energy consumption and economic growth in Africa, the roles of oil production and income level in shaping the relationship energy consumption and economic growth in Africa have been underexplored. Therefore, this study sought evaluate the direct and moderating effects of oil production and income level on energy-growth nexus in Africa.

This study is structured into five main sections. The Introduction provides the background, research problem, and objectives, along with significance of the study. The Literature Review explores conceptual perspectives on energy consumption and economic growth, and empirical findings on the roles of income level and oil production in moderating this

AROMASODUN, O. M., BIALA, M. I., & SHITU, A. M. (2025)*Energy consumption and economic growth in Africa: examining the influence of income level and oil production*

relationship. The Methodology section describes the data sources, variable definitions, model specification, and estimation techniques, justifying the chosen econometric approach. The Results and Discussion present descriptive statistics, main findings on the independent and moderating effects of income level and oil production. Finally, the Conclusion summarizes key findings, suggest policy recommendations for sustainable energy and economic growth strategies, and propose directions for future research.

2. Literature Review

Energy consumption is the quantity of energy utilized by a certain entity, such as a home, business, or nation, to carry out different tasks and operations (Energy Information Administration [EIA], 2020). Energy consumption is a complicated and multidimensional topic that involves many different aspects and circumstances that affect how much energy is used and how it is used. Economic growth, according to the National Bureau of Economic Research (NBER) (2020), is the steady rise in an economy's output of goods and services over an extended period of time. The real GDP change as a percentage is typically used to measure economic growth.

Oil production, according to the IEA, is the process of drawing oil out from the earth and extracting it, then refining and processing it into different petroleum products (IEA, 2020).

Crude oil and other petroleum products are extracted, processed, and distributed as part of the intricate and multidimensional process of oil production. Since oil is a significant source of energy for heating, transportation, and other industrial uses, comprehending the notion of oil production is essential to understanding the energy business. The term income level describes how much money a person or household makes from a variety of sources, including investments, earnings, and salaries (World Bank, 2020b). The income level divisions are based on the World Bank's categorization system, which divides African nations into three income groups: low-, lower-middle-, and upper-middle-income based on GNI per capita.

Oil Production and Economic Growth

In the literature, little or no research has been conducted on the direct and moderating effects of oil production on the relationship between energy consumption and economic growth in Africa. This is evidenced in the literature reviewed below.

Dolgopolova et al. (2014) investigated the causal relationship between energy consumption and economic development for seven non-OPEC oil producing nations using panel data covering 1969–2009. Variables used include real GDP, labour force, real capital, oil, electricity, gas, and coal consumption. Further studies show that oil consumption and real GDP Granger cause real gross capital formation in the short term, while electrical consumption and real gross fixed capital cause oil consumption in the short term, and electricity consumption and gas consumption cause electricity consumption in the short term.

AROMASODUN, O. M., BIALA, M. I., & SHITU, A. M. (2025)*Energy consumption and economic growth in Africa: examining the influence of income level and oil production*

With a difference in choice of variables employed when compared with the above study, Mensah et al. (2019) assessed the causal relationship between economic growth, the use of fossil fuels for electricity, carbon pollution, and the price of oil for 22 African nations between 1990 and 2015. Utilizing variables such as growth output, capital stock, labour, energy use (fossil fuel), carbon emissions, and oil price, the study used the PMG panel ARDL. The findings indicate a unilateral causal relationship between carbon emissions and economic growth in both the short and long term for non-oil exporters, as well as a bilateral causal relationship between economic growth and fossil fuel energy consumption and carbon emissions for all panels. However, a bidirectional causal link exists only in the long run for oil exporters.

Awodumi and Adewuyi (2020) explored how non-renewable energy affected economic growth and carbon emissions in Africa's leading oil-producing countries between 1980 and 2015. After accounting for nonlinearity and structural break in the unit root and cointegration analysis, the study employed the non-linear autoregressive distributed lag (NARDL) technique. The study demonstrates that, with the exception of Algeria, the per capita consumption of petroleum and natural gas has an uneven effect on economic development and per capita carbon emissions.

Income-Level and Economic Growth

The review of prior studies below shows that scanty research has been conducted on the role of income level in shaping the impact of energy consumption on economic growth, especially in Africa. This is reflected in the number of studies found to have been conducted in this regard.

To begin with, for a sample of low- and middle-income countries in Sub-Saharan Africa (SSA) from 1995 to 2013, Hassan et al. (2008) used panel data that included such variables as manufacturing performance, energy consumption, capital, labour inputs, corruption variable, and economic freedom variable. The authors discovered that, over time, a rise in manufacturing performance is linked to a rise in energy consumption using the Fully Modified Ordinary Least Squares approach. Both the chosen low-income and middle-income SSA countries showed same results. This suggests that both low- and middle-income sub-Saharan African nations depend on outside energy sources.

Another study by Kahsai et al. (2012) examined the relationship between energy use and economic growth in Sub-Saharan Africa. Countries in Sub-Saharan Africa are divided into two income brackets: low and middle. The findings confirm the neutrality hypothesis in the short term, with the exception of middle-income countries, and reveal a strong bidirectional causal link over the long run. The different results for low- and middle-income countries show how important income level is in the causative relationship.

Wang et al. (2018) empirically examined the connection between urbanization, economic growth, energy consumption, and CO₂ emissions, paying special emphasis to the disparities in income between the countries they examined. The study employed a balanced dataset for a panel of 170 countries, taking into account the years 1980–2011. A statistically significant positive correlation between the variables utilized over the long run and a cointegration

AROMASODUN, O. M., BIALA, M. I., & SHITU, A. M. (2025)*Energy consumption and economic growth in Africa: examining the influence of income level and oil production*

connection between the variables in all of the countries under investigation were found based on the findings of panel cointegration tests.

3. Methodology

The following models were specified based on the fundamental premises of the biophysical growth model and the neoclassical economic growth theory:

$$\left(\frac{\Delta Y}{Y}\right)_{it} = \beta_0 + \beta_1 GCF_{it} + \beta_2 LAB_{it} + \beta_3 TEN_{it} + \psi_1(TEN_{it} \times D_{OIL}) + \beta_4 D_{OIL_{it}} + \beta_5 CEM_{it} + \beta_6 FDI_{it} + \beta_7 INF_{it} + U_{it} \quad (3.1)$$

$$\left(\frac{\Delta Y}{Y}\right)_{it} = \beta_0 + \beta_1 GCF_{it} + \beta_2 LAB_{it} + \beta_3 TEN_{it} + \beta_4 D_{LMI_{it}} + \beta_5 D_{MI_{it}} + \lambda_1(TEN_{it} \times D_{LMI}) + \lambda_2(TEN_{it} \times D_{MI}) + \beta_6 CEM_{it} + \beta_7 FDI_{it} + \beta_8 INF_{it} + U_{it} \quad (3.2)$$

where $\left(\frac{\Delta Y}{Y}\right)$, GCF , LAB , TEN , CEM , FDI , and INF represents economic growth, capital stock growth, labour force growth, total energy consumption, carbon dioxide emissions, foreign direct investment and inflation, respectively. D_{OIL} is dummy variable for oil production (equals 1 for oil-producing nation and 0, otherwise) and ψ_1 is the coefficient of the interaction term. D_{LMI} is dummy variable for income level (equals 1 for lower-middle income, and 0 otherwise), D_{MI} is dummy variable (equals 1 for middle income, and 0 otherwise), reference category is low income and λ_1 and λ_2 are the coefficients of the interaction terms. Because variations in oil production may affect the price and availability of oil, which can therefore affect energy security, oil production is a significant component in energy security. Energy consumption is influenced by income level since rising incomes can raise demand for energy-intensive products and services, which in turn can raise energy consumption.

To account for the effect of investment on economic growth and productivity, capital stock growth was included. Private investment flows in constant 2015 international dollars were used to measure it. The inclusion of this variable is consistent with neoclassical theory. Labour force growth was included to reflect the effect of demographic shifts on economic growth. It was calculated as a percentage by dividing the level form 1-year lag of labour force growth by the initial difference of the level form of labour force growth. This variable's inclusion is consistent with neoclassical theory.

To capture the effect of energy on economic growth, total energy consumption is taken into account. It was expressed as the equivalent of one kilogram of oil per capital. This variable was included in line with the biophysical growth hypothesis. Following Mensah et al.'s (2019) study, carbon dioxide emission was incorporated as a variable to measure the environmental effect of economic activity. The percentage of total fuel combustion was used to measure it.

AROMASODUN, O. M., BIALA, M. I., & SHITU, A. M. (2025)*Energy consumption and economic growth in Africa: examining the influence of income level and oil production*

In accordance with Wang et al. (2020), foreign direct investment was included to account for capital accumulation and technical advancement. It was expressed as a GDP percentage. Since excessive inflation can discourage investment and consumption and impede economic progress, it was listed as a factor. It was computed as the consumer price index change as a percentage every year. Inflation was employed as a predictor by Mahadevan and Asafu-Adjaye (2007) and Zamani (2012).

From World Bank Development Indicators, the panel data covering the 54 African countries for the period between 1990 and 2023 were used for the study aside dummy variables which were computed by the authors.

4. Results and Discussion

4.1 Descriptive Analysis

The results from Table 1 reveal that the mean and standard deviation of economic growth, ($\Delta Y/Y$), were 3.80 and 10.42 percent, respectively, with a minimum value of -109.97 percent and maximum value of 149.97 percent. In the case of capital stock growth, GCF, the mean and standard deviation were 20.50 and 12.54 percent respectively, with a minimum value of -42.74 percent and a maximum value of 143.78 percent. Also, the mean and standard deviation for labour force growth, LAB, were 2.39 and 1.14 percent respectively, with a minimum value of -5.28 percent and a maximum value of 16.62 percent.

As regards inflation, INF, its mean and standard deviation were 13.109 and 116.27 percent, with a minimum of -99.78 percent and a maximum value of 4145.11 percent. As for energy consumption, TEN, the mean and standard deviation were 646.48 and 892.15 percent respectively, with a minimum value of -4511.85 percent and a maximum value of 5922.17 percent. Concerning of carbon emission, CEM, its mean and standard deviation were 14.84 and 11.69 percent respectively, with a minimum value of -9.11 percent and a maximum value of 64.24 percent. Regarding foreign direct investment, FDI, the mean and standard deviation were 4.47 and 10.37 percent respectively, with a minimum value of -40.31 percent and a maximum value of 161.82 percent..

Table 1. Descriptive statistics

Variable	Description	Mean	Std. Dev.	Min	Max	Obs
$\left(\frac{\Delta Y}{Y}\right)$	Economic growth (Annual GDP growth %)	3.80	10.42	-109.96	149.97	1,458
GCF	Capital stock growth (Gross capital formation)	20.50	12.54	-42.74	143.78	1,296
LAB	Labour force growth (Population growth)	2.39	1.14	-5.28	16.62	1,458
INF	Inflation (Annual percent change in CPI)	13.109	116.27	-99.78	4145.10	1,404
TEN	Energy consumption (KG of oil per capital)	646.48	892.15	-4511.84	5922.17	1,080

AROMASODUN, O. M., BIALA, M. I., & SHITU, A. M. (2025)*Energy consumption and economic growth in Africa: examining the influence of income level and oil production*

<i>CEM</i>	Carbon dioxide emission (% of total fuel combustion)	14.84	11.69	-9.11	64.243	540
<i>FDI</i>	Foreign direct investment (% of GDP)	4.47	10.37	-40.31	161.82	1,458
<i>D_{OIL}</i>	Dummy variable (oil production)	0.425	0.494	0	1	1,458
<i>D_{LMI}</i>	Dummy variable (low-income level)	0.5	0.500	0	1	1,458
<i>D_{MI}</i>	Dummy variable (middle-income level)	0.185	0.388	0	1	1,458

Source: Authors' computation (2025).

4.2 Correlation Matrix

Table 2 showcases the correlation matrix for the explanatory and control variables. The p-values of the correlation coefficients in the table shows the statistical significance of the correlation between each pair of the variables. Based on the 5% statistical significance, the magnitude of the coefficients, each being less than 0.6, indicates that the variables were correlated but not perfectly correlated. Thus, there was no evidence of multicollinearity problem in this study.

Table 2. Correlation Matrix for Oil Production

	$\left(\frac{\Delta Y}{Y}\right)$	GCF	LAB	INF	TEN	CEM	FDI	D _{OIL}	TEN× D _{OIL}	D _{LMI}	TEN× D _{LMI}	D _{MI}	TEN× D _{MI}
$\left(\frac{\Delta Y}{Y}\right)$	1.000												
GCF	0.296 (0.000)	1.000											
LAB	0.107 (0.000)	0.100 (0.000)	1.000										
INF	-0.013 (0.615)	0.006 (0.810)	0.018 (0.478)	1.000									
TEN	-0.090 (0.003)	-0.120 (0.000)	-0.119 (0.000)	-0.025 (0.507)	1.000								
CEM	0.047 (0.271)	0.062 (0.170)	0.152 (0.000)	-0.045 (0.302)	0.104 (0.015)	1.000							
FDI	0.022 (0.398)	0.355 (0.000)	0.143 (0.000)	0.011 (0.663)	-0.165 (0.000)	-0.012 (0.766)	1.000						
D _{OIL}	-0.045 (0.089)	0.201 (0.000)	0.042 (0.106)	0.059 (0.026)	0.196 (0.000)	-0.243 (0.000)	0.077 (0.003)	1.000					
D _{LMI}	0.072 (0.005)	-0.075 (0.006)	-0.075 (0.004)	0.024 (0.377)	0.023 (0.000)	-0.264 (0.953)	-0.002 (0.000)	-0.166 (0.000)	1.000				
D _{MI}	0.046 (0.078)	0.260 (0.000)	-0.240 (0.000)	-0.037 (0.156)	0.492 (0.000)	0.070 (0.102)	0.043 (0.100)	0.264 (0.000)	-0.476 (0.000)	1.000			
TEN× D _{OIL}	-0.118 (0.000)	-0.084 (0.102)	-0.051 (0.000)	-0.010 (0.012)	0.752 (0.000)	-0.027 (0.127)	-0.161 (0.019)	0.514 (0.000)	-0.312 (0.000)	0.537 (0.000)	1.000		
TEN× D _{LMI}	0.031 (0.297)	-0.106 (0.000)	-0.052 (0.087)	0.038 (0.208)	-0.066 (0.028)	0.121 (0.004)	-0.154 (0.000)	-0.071 (0.019)	0.761 (0.000)	-0.511 (0.000)	-0.198 (0.000)	1.000	
TEN× D _{MI}	-0.094 (0.002)	-0.084 (0.009)	-0.122 (0.001)	-0.031 (0.308)	0.959 (0.000)	0.031 (0.476)	-0.118 (0.001)	-0.220 (0.000)	-0.424 (0.000)	0.632 (0.000)	0.774 (0.000)	-0.323 (0.000)	1.000

Source: Authors' computation (2025)

AROMASODUN, O. M., BIALA, M. I., & SHITU, A. M. (2025)*Energy consumption and economic growth in Africa: examining the influence of income level and oil production*

4.3 Results of the ADF Unit Root Test

As can be seen from Table 3 below, the results reveal some variables to be stationary at the level form at the chosen 5% significance level (viz $(\Delta Y/Y)$, INF, FDI, D_OIL, D_LMI, and D_MI) while others (viz GCF, LAB, TEN, CEM, TEN×D_OIL, TEN×D_LMI, and TEN×D_MI) were stationary only at first difference. Moreover, the tests revealed that all the variables that were not stationary at the level became stationary after first differencing, judging from the respective p-values of the t-statistics that are all lower than 0.05 in all the affected cases. This means that some of the variables had unit roots in their level form and it also implies that the use of OLS method to estimate the equations would be prone to give spurious results. This therefore necessitated testing for co-integration to check if there exists a long-run relationship among the variables. This test was conducted, and the results are presented and discussed in the next sub-section.

Table 3. Results of the Unit Root Tests for Oil Production

Variables	Stationary	t-Stat	p-values	Order of Integration	Conclusion
$(\frac{\Delta Y}{Y})$	At Level	-12.872	0.000	I(0)	Stationary or I(0) at the level form
GCF	At Level	-1.193	0.115	I(1)	Unit root or I(1) at the first difference
	At First Difference	-2.798	0.002	I(0)	
LAB	At Level	-1.111	0.133	I(0)	Unit root or I(1) at the level form
	At First Difference	-6.843	0.000	I(0)	
INF	At Level	-2.859	0.002	I(0)	Stationary or I(0) at the level form
TEN	At Level	-1.441	0.074	I(1)	Unit root or I(1) at the first difference
	At First Difference	-2.117	0.024	I(0)	
CEM	At Level	-1.451	0.073	I(1)	Unit root or I(1) at the first difference
	At First Difference	-2.091	0.015	I(0)	
FDI	At Level	-2.4376	0.007	I(0)	Stationary or I(0) at the level form
D_OIL	At Level	-3.410	0.000	I(0)	Stationary or I(0) at the level form
TEN× D_OIL	At Level	-1.441	0.074	I(1)	Unit root or I(1) at the first difference
	At First Difference	-6.012	0.000	I(0)	
D_LMI	At Level	-2.800	0.000	I(0)	Stationary or I(0) at the level form
TEN× D_LMI	At Level	-1.981	0.918	I(1)	Unit root or I(1) at the first difference
	At First Difference	-2.921	0.012	I(0)	
D_MI	At Level	-2.420	0.000	I(0)	Stationary or I(0) at the level form
TEN× D_MI	At Level	-1.871	0.718	I(1)	Unit root or I(1) at the first difference
	At First Difference	-2.901	0.025	I(0)	

Source: Authors' computation (2025)

4.4 Panel Cointegration Test

The long-run relationship between the dependent and independent variables was examined using the Kao co-integration test approach. The test's hypothesis and decision rule are the null hypothesis, which states that there is no long-term relationship, and the alternative, which states that there is. If the t-statistic's probability value is less than or equal to the selected 5% critical value, the null hypothesis is rejected; if not, the hypothesis is accepted and a long-term relationship is concluded to exist.

AROMASODUN, O. M., BIALA, M. I., & SHITU, A. M. (2025)*Energy consumption and economic growth in Africa: examining the influence of income level and oil production*

After the test, the t-statistic with p-values for the two equations were -8.058 (0.000) and -8.299 (0.000). Because the p-value was 0.000 in each case, which is less than the 0.05 significance level, it was concluded that there was a long-run relationship between the dependent and independent variables, and the null hypothesis was rejected. Hence the Random Effect method was used to estimate the equations as indicated by the Hausman test.

4.5 Estimates of the Regression Equations

4.5.1 Direct and Moderating Effects of Income Level

The results estimated from Equation 3.2 are depicted in Table 4 where the coefficient estimates of the independent dummy variables D_{LMI} and D_{MI} were positive and statistically significant being, 34.718 and 35.623 with p-values of 0.000 in each case respectively. Also, the coefficients of their interactions with energy consumption, $[TEN \times D]_{LMI}$ and $[TEN \times D]_{MI}$, being 0.038 and 0.041 with p-values of 0.000 in each case, implies that the coefficients were positive and statistically significant, suggesting that the higher the income level of the country, the higher the level of energy consumption which in turn led to higher economic growth. The significant positive result is in line with findings of previous empirical studies such as Apergis and Payne (2010) and Hasssan et al (2008).

The coefficients of labour force growth (LAB), total energy consumption (TEN) and foreign direct investment (FDI) were positive and statistically significant, being 1.459, 0.124 and 0.399 with p-values of 0.012, 0.000 and 0.000 respectively, while all other variables were insignificant.

Table 4 The OLS Estimates of the Regression Equation for Income Level

Variables	Coeff.	Z-Stat.	P-value
GCF	-0.004	-0.07	0.944
LAB	1.459	2.51	0.012
INF	-0.012	-0.67	0.504
TEN	0.124	8.64	0.000
CEM	-0.015	-0.35	0.729
FDI	0.399	6.82	0.000
D_{LMI}	34.718	9.63	0.000
$TEN \times D_{LMI}$	0.038	6.87	0.000
D_{MI}	35.623	8.35	0.000
$TEN \times D_{MI}$	0.041	8.48	0.000
χ^2	189.56		0.000
Method of Estimation	RE		

Source: Authors' computation (2025)

Gross capital stock (GCF) had a mix of positive and negative effects. The reason for this mixed outcome is because African nations are at different levels of economic development, with some being more industrialized and others being more rural. As a result, blocs having a

AROMASODUN, O. M., BIALA, M. I., & SHITU, A. M. (2025)*Energy consumption and economic growth in Africa: examining the influence of income level and oil production*

favourable influence on economic growth may have a strong industrial base, whereas those with a negative effect may have a weak one. The positive effect of labour force growth (LAB) indicates that economic development benefits from a rising and productive labour force growth. The negative impact of inflation (INF) can delay economic growth and lower industrial productivity. This is because rising energy prices brought on by inflation make it more expensive for businesses and industries to operate. The effect of total energy consumption (TEN) was positive, indicating that increasing economic production is supported by increasing energy consumption. Carbon dioxide emissions (CEM) showed no significant effect. The reason for this might be that Africa has not yet reached the heavy-emission phase of industrialization, characteristic of advanced nations. The positive effect of foreign direct investment (FDI) may be attributed to the fact that FDI frequently provides cutting-edge technology and skills that can increase energy efficiency and spur overall economic growth.

4.5.2 Direct and Moderating Effects of Oil Production

The results from the estimation of Equation 3.1 are displayed in Table 5, where the coefficient estimates of oil production (D_OIL) and that of its interaction with energy consumption TEN ($\times D$) _OIL) were -0.000 and -1.722 with p-values greater than 0.05, implying that the coefficients were negative and statistically insignificant. This indicates that there was no significant difference in the effect of energy consumption on economic growth between oil producing nations and non-oil producing nations. This study is not aware of any previous study that has examined the possible influence of oil production on the effects of energy consumption on economic growth and, as a result of this, there is no previous study to compare this finding with.

Table 5. The OLS Estimates of the Regression Equation for Oil Production

Variables	Coeff.	Z-Stat.	P-value
GCF	0.213	3.74	0.000
LAB	1.287	2.16	0.031
INF	-0.047	-2.49	0.013
TEN	0.002	0.60	0.546
CEM	0.077	1.61	0.107
FDI	0.033	0.64	0.524
D_OIL	-1.722	-0.57	0.571
TEN $\times$ D_OIL	-0.005	-0.13	0.893
χ^2	60.65		0.000
Method of Estimation	RE		

Source: Authors' computation (2025)

The coefficients of capital stock growth (GCF) and labour force growth (LAB) were positive and statistically significant, being 0.213 and 1.287 with p-values of 0.000 and 0.031, respectively. Inflation (INF) coefficient was negative and statistically significant, being -0.047 with a p-value of 0.031, while all other variables were insignificant.

AROMASODUN, O. M., BIALA, M. I., & SHITU, A. M. (2025)*Energy consumption and economic growth in Africa: examining the influence of income level and oil production*

5. Conclusion

This study has demonstrated that energy consumption is a powerful engine of economic growth across Africa, yet its potency is neither uniform nor unconditional. This study investigated the roles of income level and oil production in shaping the effect of energy consumption on economic growth in Africa. The findings confirm that energy consumption significantly contributes to economic growth, but the extent of this impact varies by a country's income level. They reveal that income level has both positive independent and moderating effects on economic growth. In higher-income economies—where infrastructure is more robust, markets function more efficiently, and human capital is relatively abundant—additional energy inputs translate directly into larger output gains. Conversely, in lower-income countries the potential of energy to spur growth is blunted by chronic power shortages, limited grid reach, and skills deficits that prevent firms and households from harnessing new capacity. Contrary to our hypothesis, oil production exhibits no independent or moderating impact on growth; this suggests that many African states may be failing to channel hydrocarbon revenues into productive investments, or that resource-sector distortions neutralize any direct expansionary benefits. Among control variables, inflation has a negative effect on economic growth, while labour force growth, total energy consumption, and foreign direct investment have positive impacts. Finally, there are mixed effects from the growth rate of capital stock and carbon dioxide emissions.

The finding that income level plays a dual role, acting as both a growth driver and a moderating factor that shapes the energy-growth nexus emphasizes the importance of tailored energy policies that address economic disparities and optimize resource utilization. Given the non-significance of oil production in our results, policymakers should prioritize reinvesting petroleum revenues into human-capital development, grid modernization, and economic diversification rather than relying on extractive-sector expansion alone. Moreover, macroeconomic stability—especially prudent inflation management—remains indispensable for preserving the returns on energy investments.

Despite these contributions, our analysis is constrained by uneven data quality across countries—especially among the lowest-income group—where reporting lags and measurement errors in both energy statistics and national accounts may bias our coefficient estimates. Future research should explore the role of renewable energy sources and institutional factors in shaping Africa's energy-growth dynamics. Likewise, disaggregating energy sources to distinguish the growth impacts of solar, wind, hydro, and biomass—as well as their interactions with storage technologies and grid reliability—will illuminate which mixes deliver the greatest dividends.

AROMASODUN, O. M., BIALA, M. I., & SHITU, A. M. (2025)*Energy consumption and economic growth in Africa: examining the influence of income level and oil production*

References

- African Energy Commission [AFREC], (2020). Africa energy balance 2020.
- Apergis, N, & Payne, J. E. (2010). A panel study of nuclear energy consumption and economic growth. *Energy Economics*, 32: 545-549.
- Awodumi, O. B., & Adewuyi, A. O. (2020). The role of non-renewable energy consumption in economic growth and carbon emission: Evidence from oil producing economies in Africa. *Energy Strategy Reviews*, 27, 100434.
- Dolgoplova, I., Hye, Q. A. M. & Stewart, I. T. (2014). Energy consumption and economic growth: evidence from non-OPEC oil producing states. *Quality and Quantity* 48, 887–898.
- Energy Information Administration [EIA], (2020). Energy Consumption.
- Energy Information Administration [EIA], (2022). Energy Consumption.
- Hassan, S., Danmaraya, I. A., & Danlami, M. R. (2008). Energy consumption and manufacturing performance in Sub-Saharan Africa: Does income group matter? *International Journal of Energy Economics and Policy*, 8(1), 175-180.
- Kahsai, M. S., Nondo, C., Schaeffer, P. V., & Gebremedhin, T. G. (2012). Income level and the energy consumption–GDP nexus: Evidence from Sub-Saharan Africa. *Energy Economics*, 34(3), 739–746.
- Mahadevan, R. & Asafu-Adjaye, J. (2007). Energy consumption, economic growth and prices. A reassessment using panel VECM for developed and developing countries. *Energy Policy*, 35, 2481-2490.
- Mensah, I. A., Sun, M., Gao, C., Omari-Sasu, A. Y., Zhu, D., Ampimah, B. C., & Quarcoo, A. (2019). Analysis on the nexus of economic growth, fossil fuel energy consumption, CO2 emissions and oil price in Africa based on a PMG panel ARDL approach. *Journal of Cleaner Production*. 161-174.
- National Bureau of Economic Research [NBER], (2020). Economic Growth.
- Wang, S., Li, G., & Fang, C. (2018). Urbanization, economic growth, energy consumption, and CO2 emissions: Empirical evidence from countries with different income levels. *Renewable and Sustainable Energy Reviews*, 81, 2144–2159.
- Wang, Z., Bui, Q., & Zhang, B. (2020). The relationship between biomass energy consumption and human development: Empirical evidence from BRICS countries. *Energy* 194.
- World Bank, (2020a). Energy overview: Africa.
- World Bank (2020b). Income and Poverty.
- Zamani, M. (2012). Evaluating the relationship between the energy consumption and the macroeconomic indicators. *Research Journal of Environmental and Earth Sciences*, 4(12), 1025-1032.